Solid Waste Landfills as a Repository for ABR

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Disposal of Arsenic-Bearing Water Treatment Residuals:
Assessing the Potential for Environmental Contamination

Topics

- Types of landfills
  - Regulations
  - Engineering Controls
  - Chemical environments
- Fate of metals/metalloids in landfills
  - Concerns
  - Factors affecting risk to environment
  - Leachability

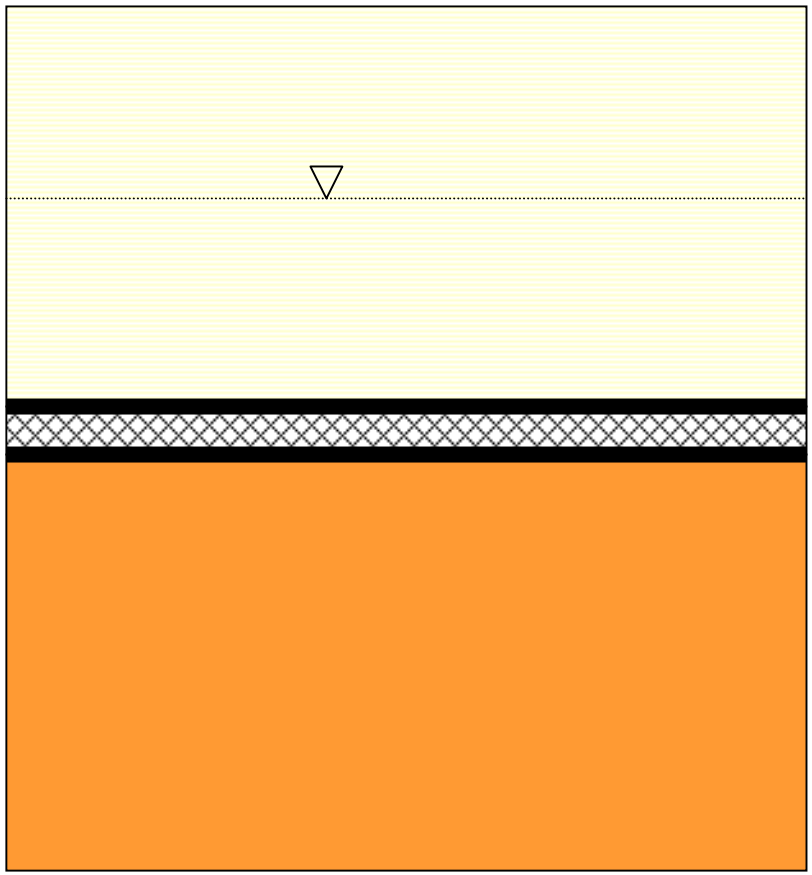
Types of Landfills

- Hazardous waste landfills
- Municipal solid waste landfills
- Other types
  - Construction and demolition debris
  - Industrial waste landfills

Hazardous Waste Landfills: RCRA Subtitle C Landfill (40 CFR 264)

Typical Subtitle C Liner

Double Liner



2 ft drainage material
Designed to maintain
less than 1ft head on liner

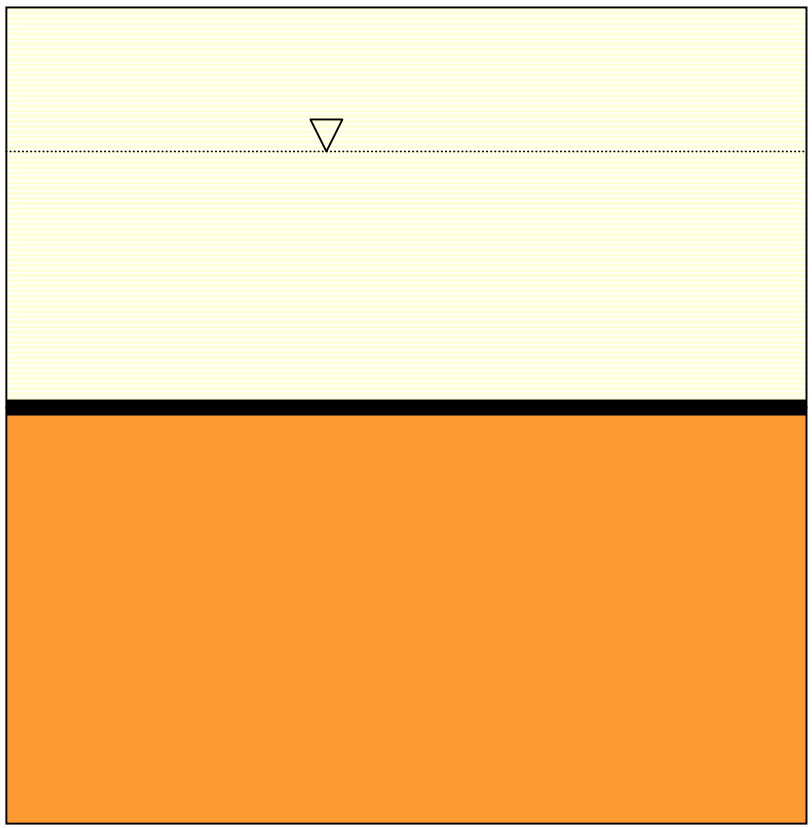
HDPE Geomembrane
Geonet
HDPE Geomembrane

3 ft compacted soil
K <= 10^{-7} cm/sec

MSW Landfills: RCRA Subtitle D Landfill (40 CFR 258)

Typical Subtitle D Liner

Single Composite Liner



2 ft drainage material
Designed to maintain
less than 1ft head on liner

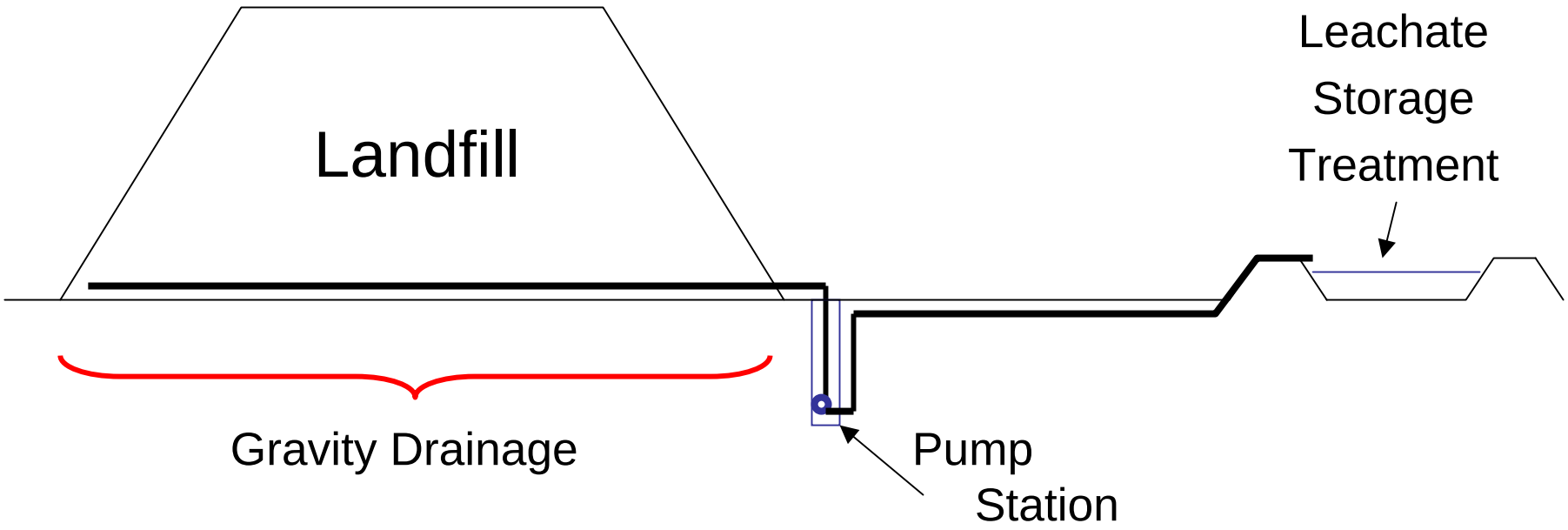
60 mil HDPE
Geomembrane

2 ft compacted soil
K <= 10^{-7} cm/sec


CP-563D
9ZW00149


DEERE
544H

Leachate is then sent to Treatment and/or Storage Facility



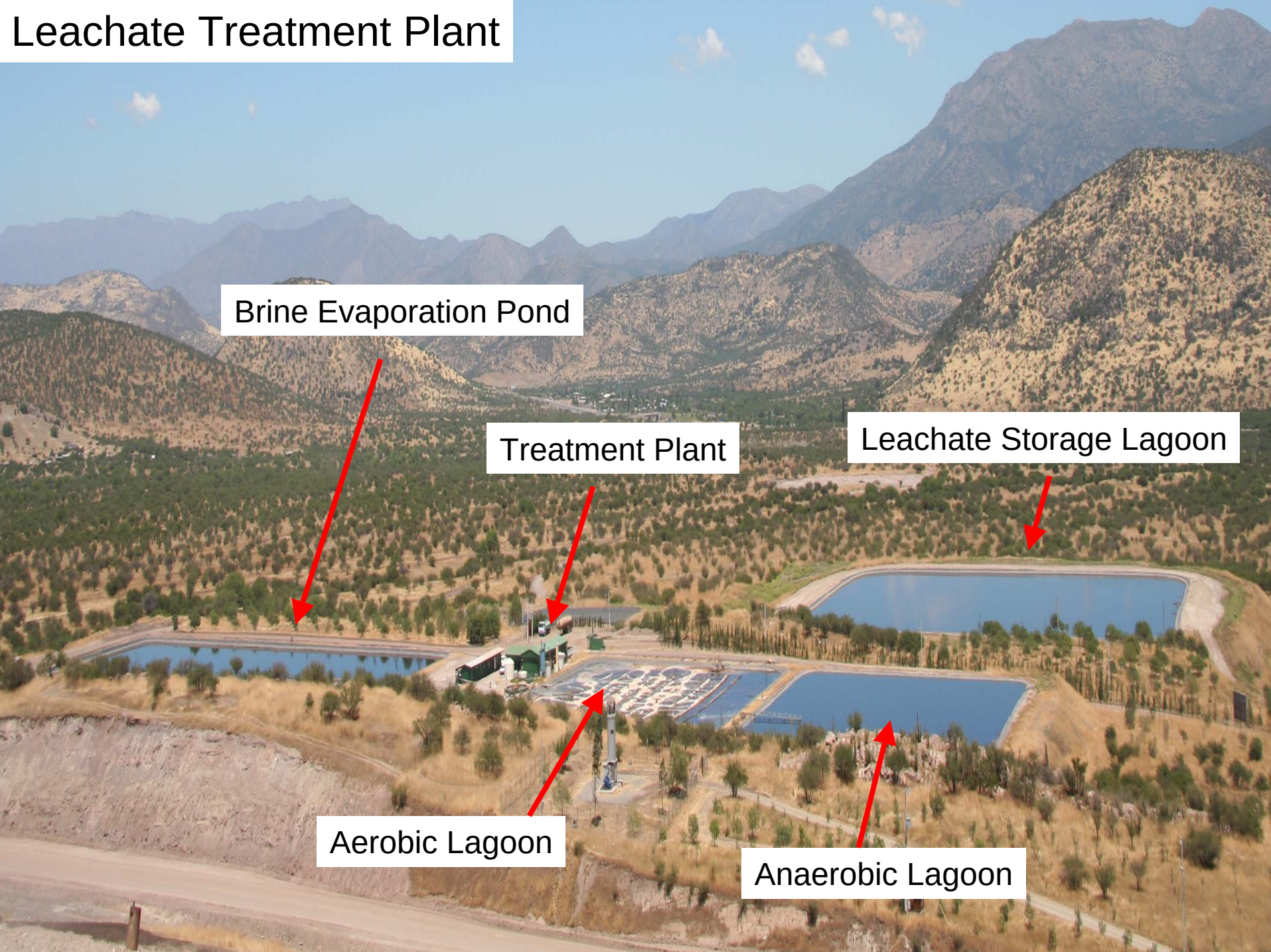

CAT


Lined Leachate Lagoon

Lined Leachate Lagoon

Leachate Storage Tank

Leachate Storage/Treatment Tanks


Leachate Treatment Plant
Brine Evaporation Pond
Treatment Plant
Leachate Storage Lagoon
Aerobic Lagoon
Anaerobic Lagoon

Aerobic Treatment Lagoon

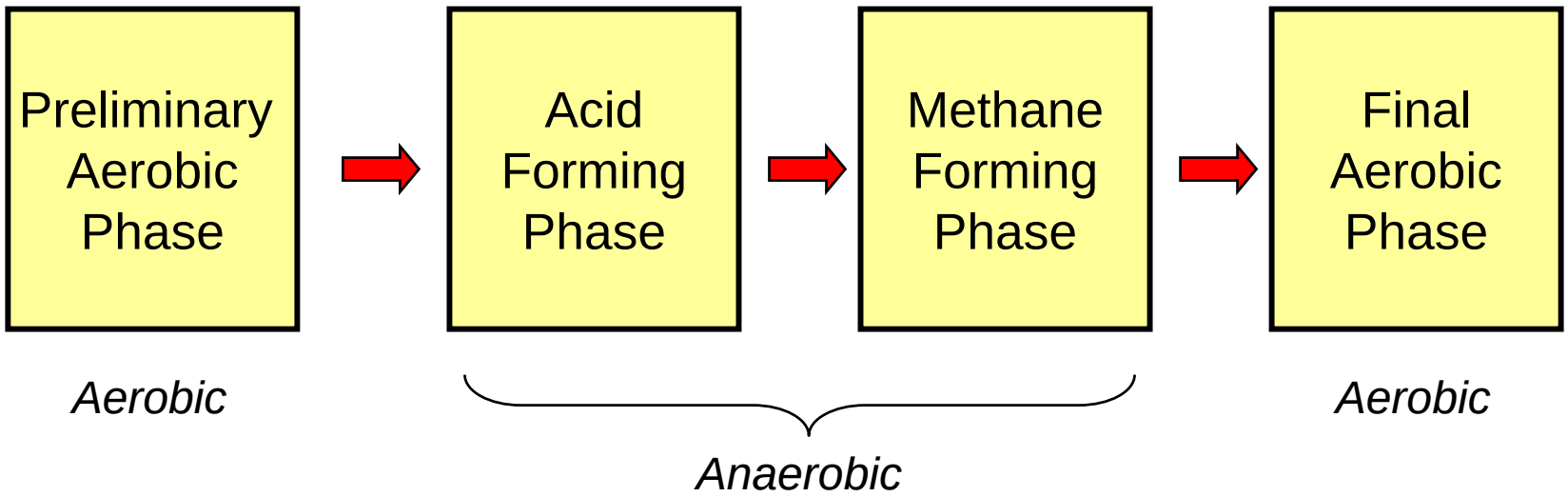
Reverse Osmosis Treatment

Leachate Treatment Using Wetlands

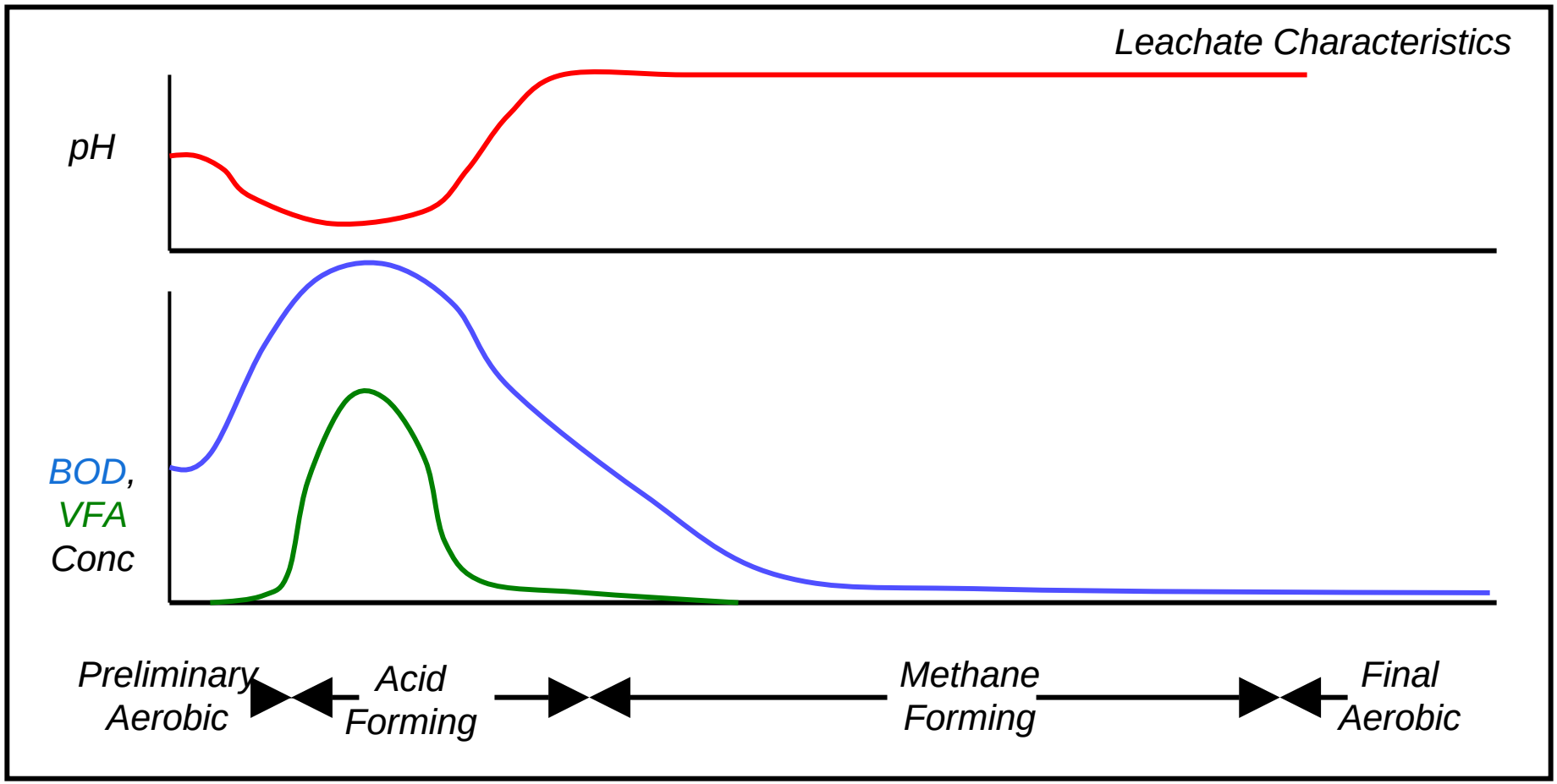
Leachate Recirculation to Landfill using Spray Irrigation

Leachate Recirculation to Landfill using Horizontal Trenches

Waste Stabilization in MSW Landfills



Waste Stabilization in MSW Landfills

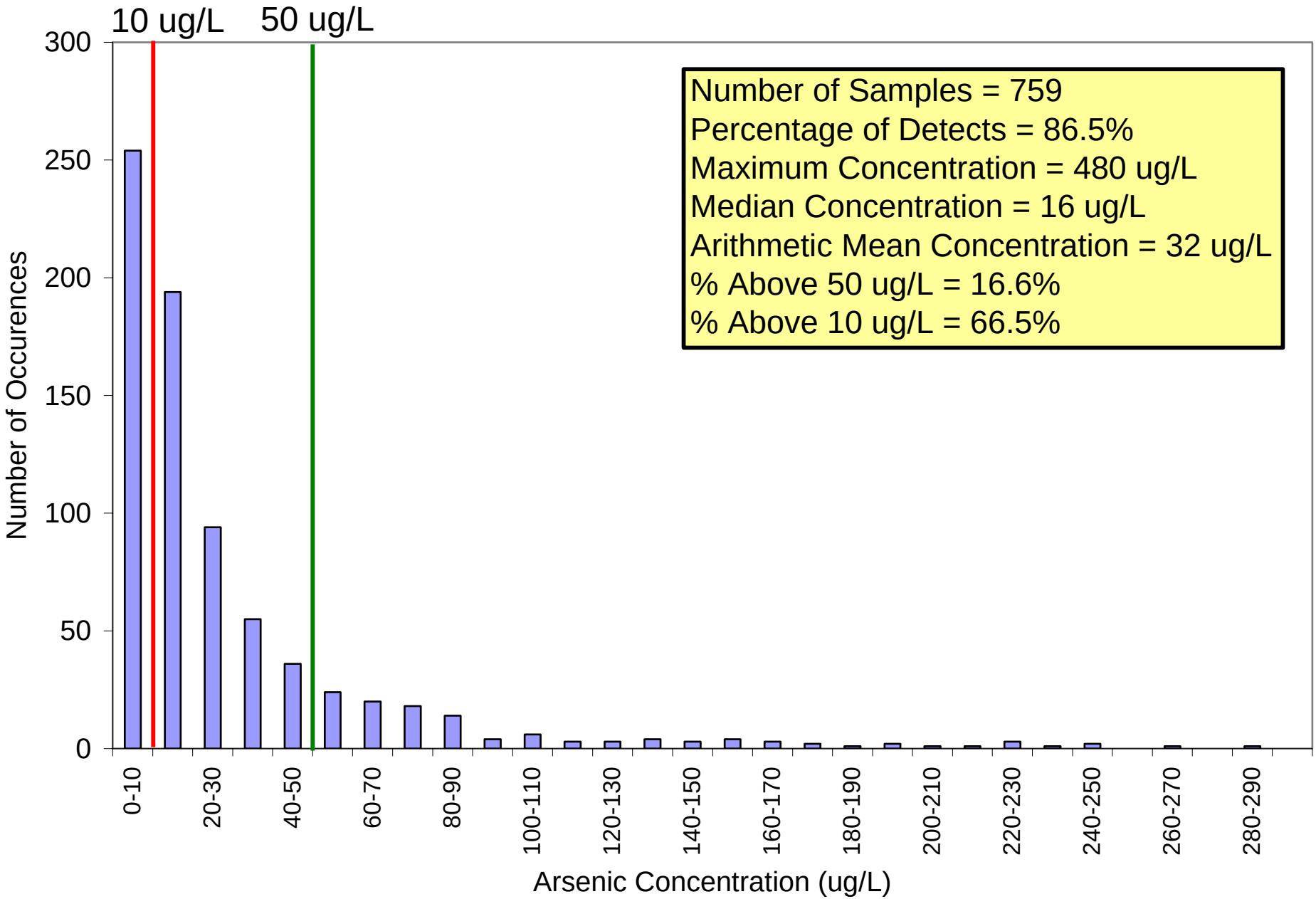


Concentrations in MSW Landfill Leachates

National Database of 200 Landfills

Statistic	Arsenic	Lead
Number Samples	2,444	2,539
% Detected	71.1	50.2
5th Percentile	4	2
10th Percentile	6	4
Median	20	21
Mean	441	133
90th Percentile	100	250
95th Percentile	260	500
GWCTL	50 (10)	15

Arsenic in Florida Landfill Leachate



Other Landfill Types

- Construction and demolition (C&D) debris landfills

- Industrial waste landfills

C&D Debris Landfill

Approximately ½ of states have liner requirements

Unlined Landfill for Hurricane Katrina Debris


WEED EATER

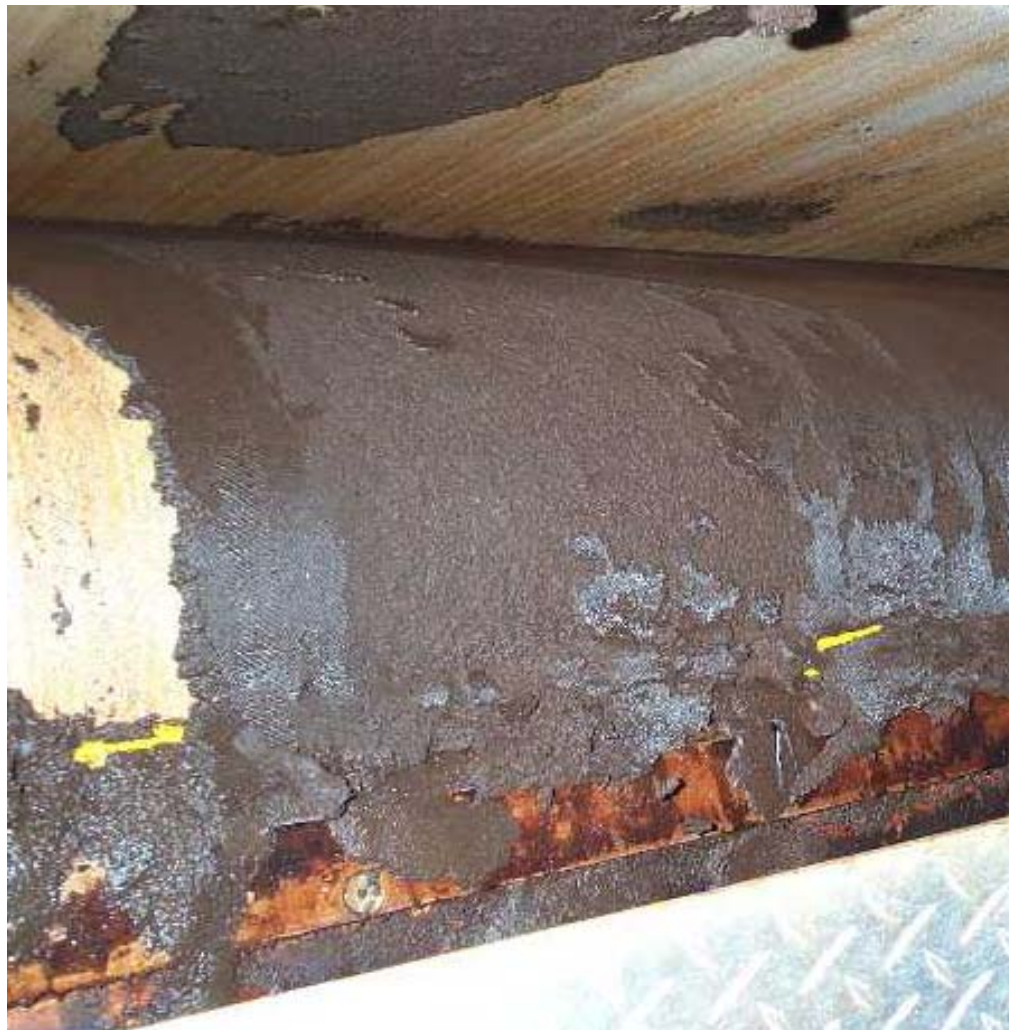
Concentrations in C&D Debris Landfill Leachates

National Database of 22 Landfills

Statistic	Arsenic	Lead
Number Samples	48	68
% Detected	54.2	60.3
5th Percentile	5	2.9
10th Percentile	8	4
Median	32.5	40
Mean	34.9	122
90th Percentile	75	220
95th Percentile	77.3	360
GWCTL	50 (10)	15

ABR Disposal?

- Hazardous waste disposal unlikely
- MSW landfill (would probably accept if ABR meets liquids restrictions)
- Other (depends on state regulations)



Ferric coagulant drinking water sludge in Florida


950E
CAT

Metal-bearing wastes are disposed in landfills

Lead-Based Paint

Mercury Lamps


Treated Wood


Wood Ash

Discarded Electronic Devices

Potential Problems Posed

- Groundwater contamination (primarily an unlined landfill issue)
- Impact on leachate quality
- Impact on gas quality (e.g., Hg)
- Long-term operation issues

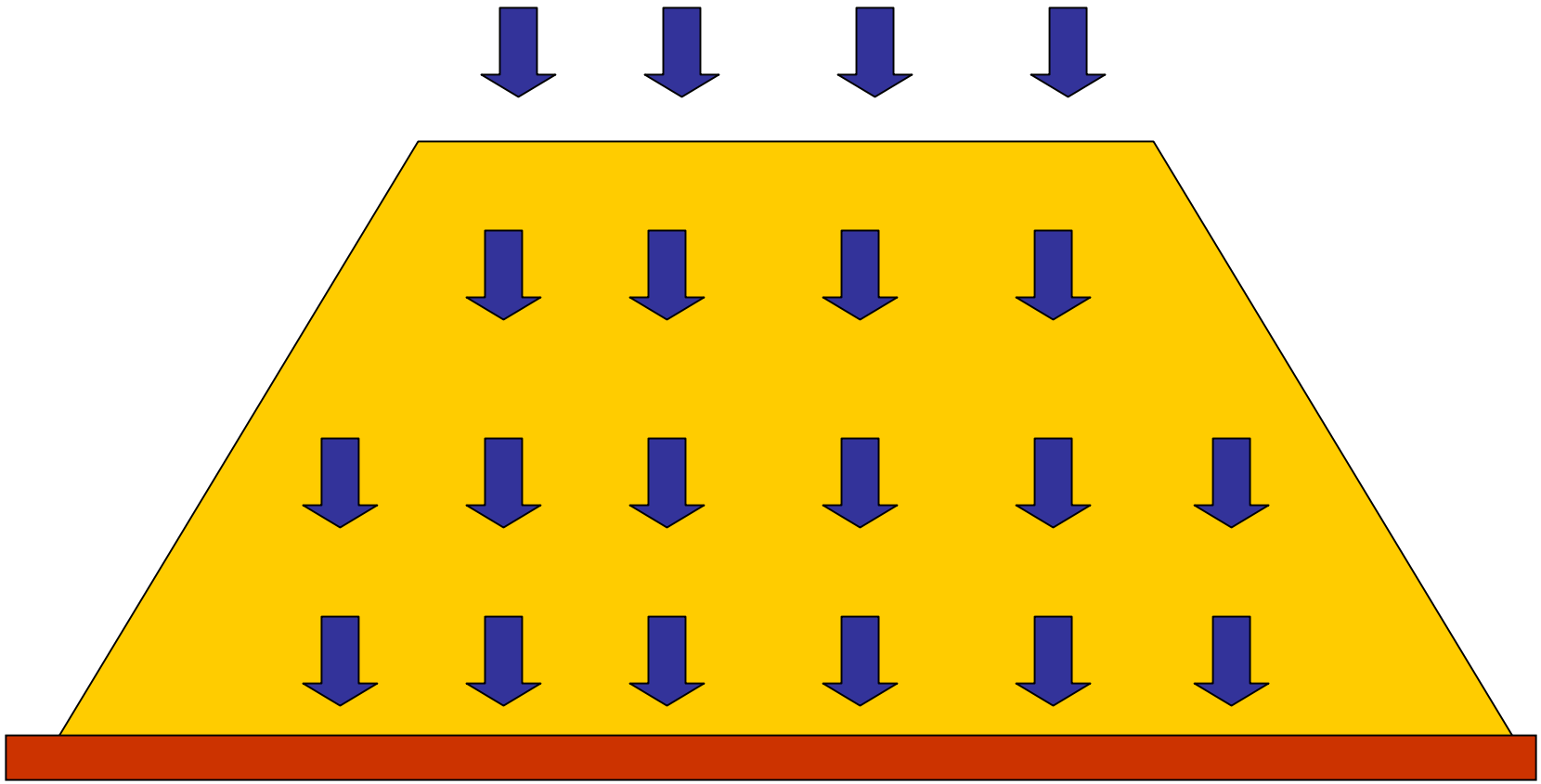
Factors to be Considered

- Leachability
- Rainfall and amount of leachate
- Fraction in the landfill

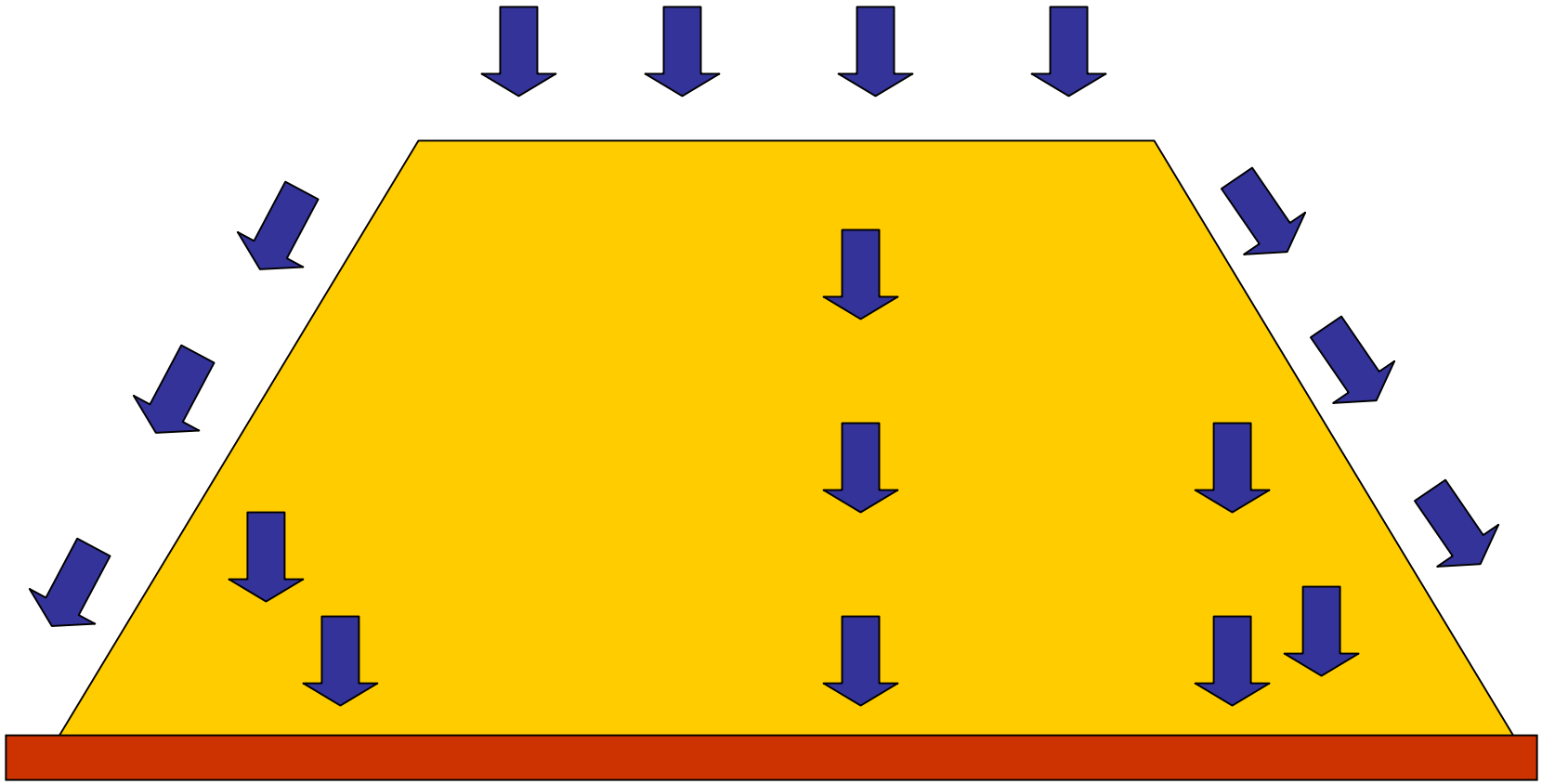
Important Point

- A majority of the waste in modern landfills stays dry

Incorrect Perception



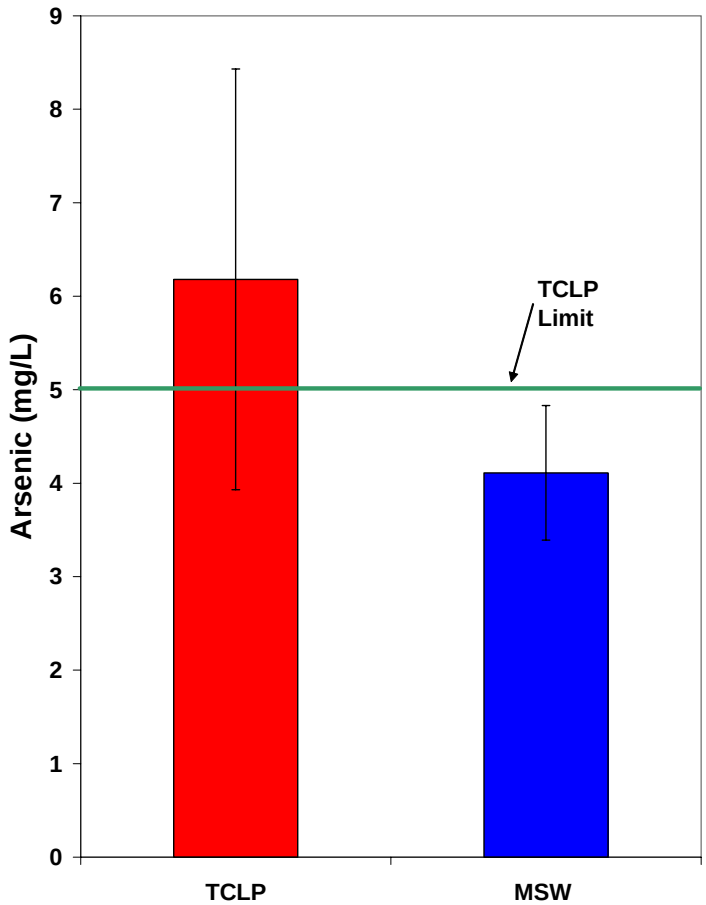
More Accurate Perception



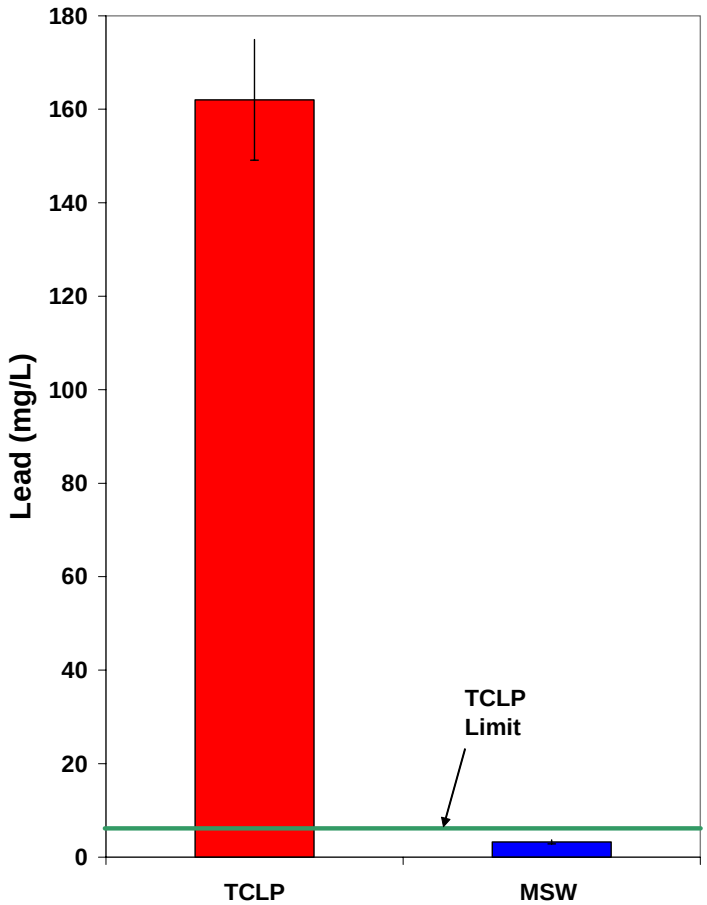
A Few Comments on Leaching

- Several studies show that TCLP may not be reflective of leaching that will occur in a landfill for some wastes.
- TCLP does not always under predict leaching.

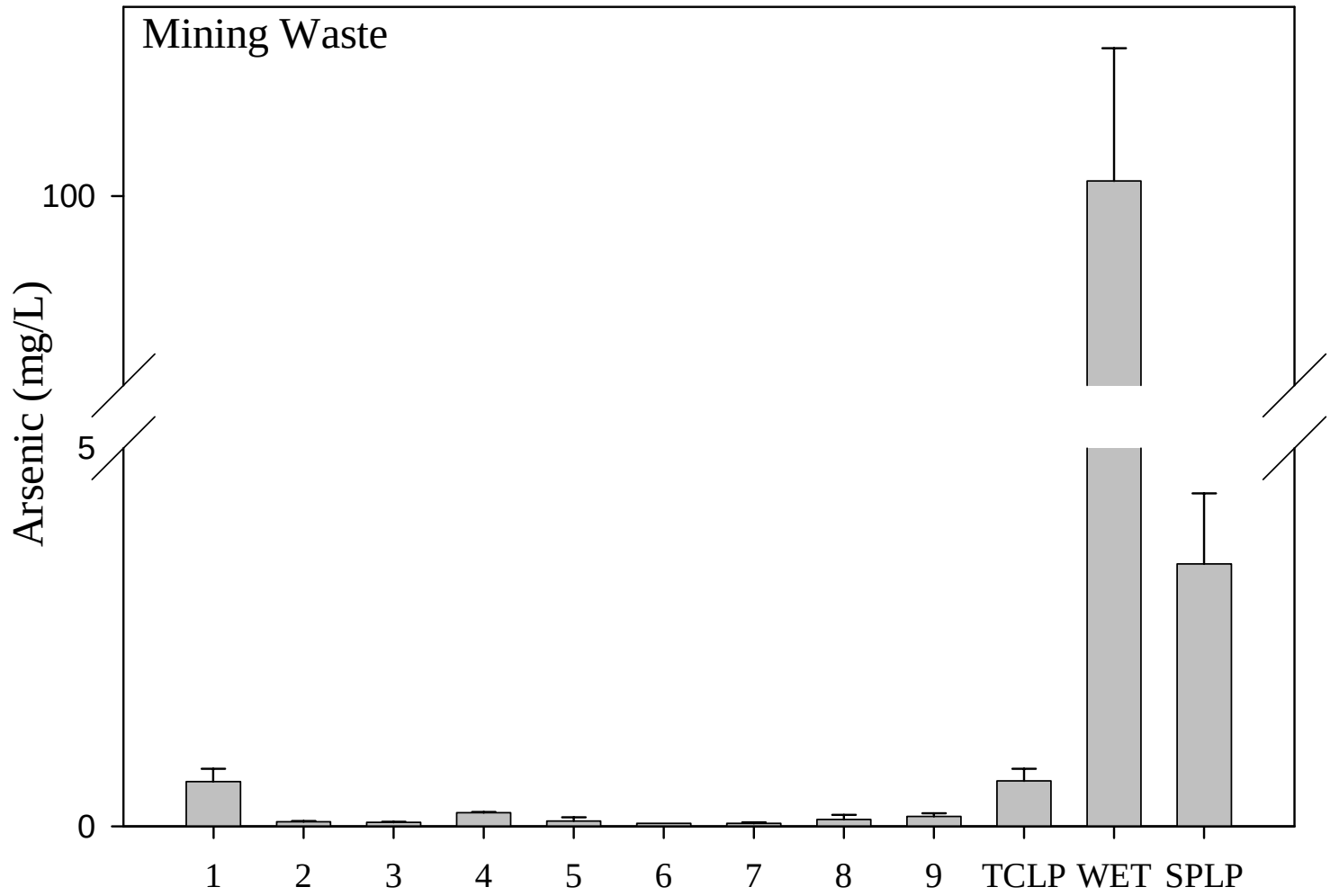
Leaching in MSW LF Leachate

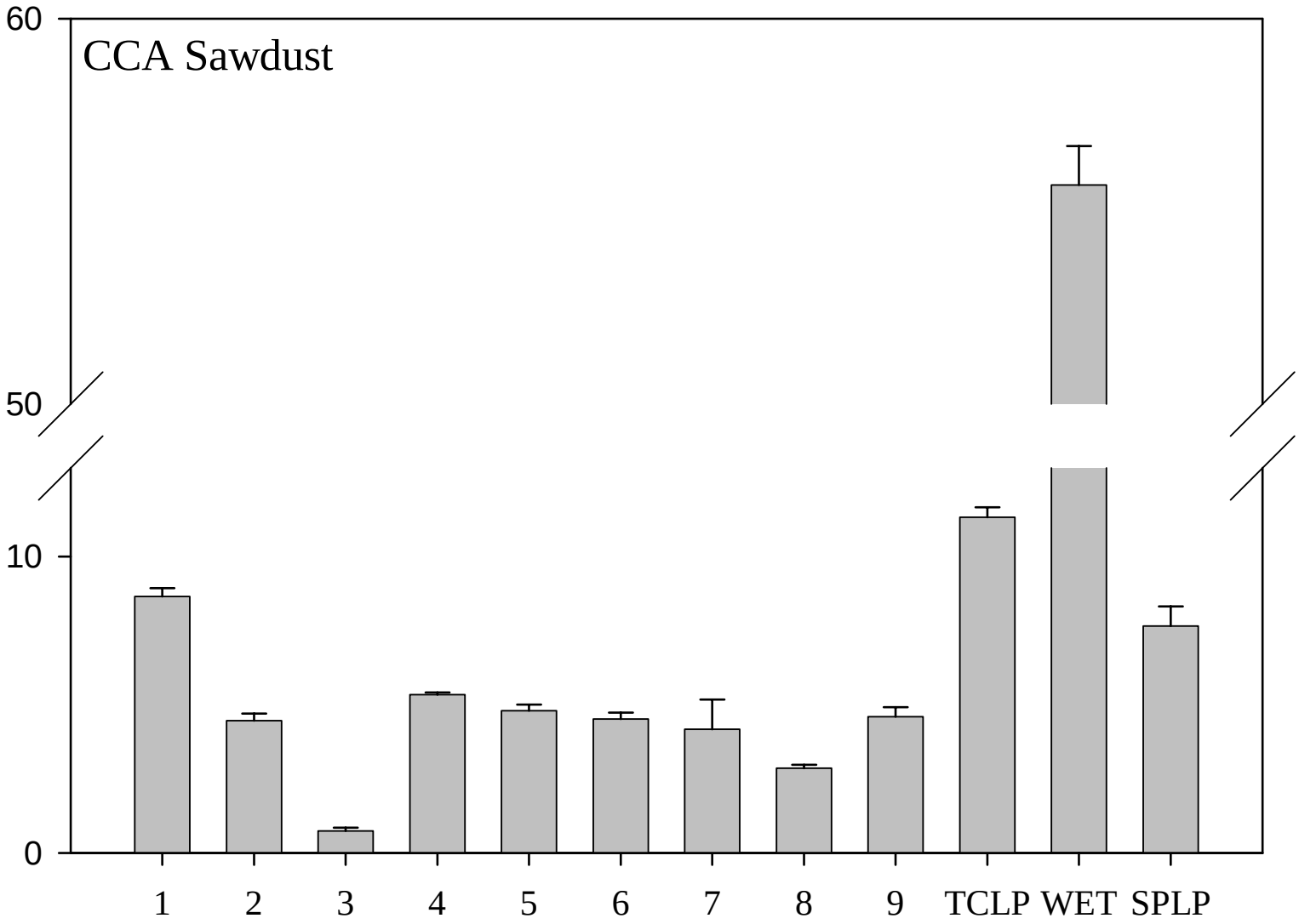


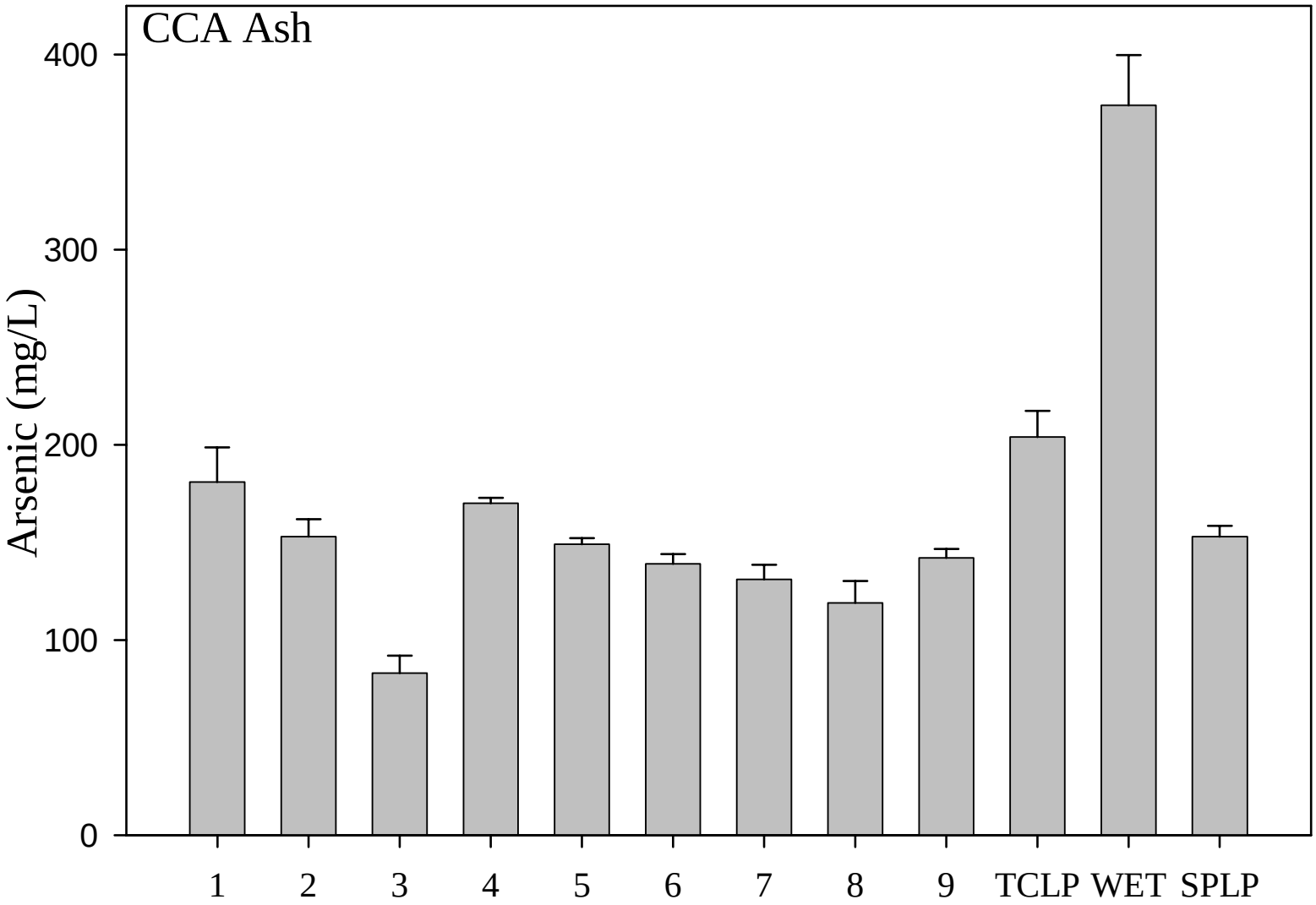
CCA-Treated Wood

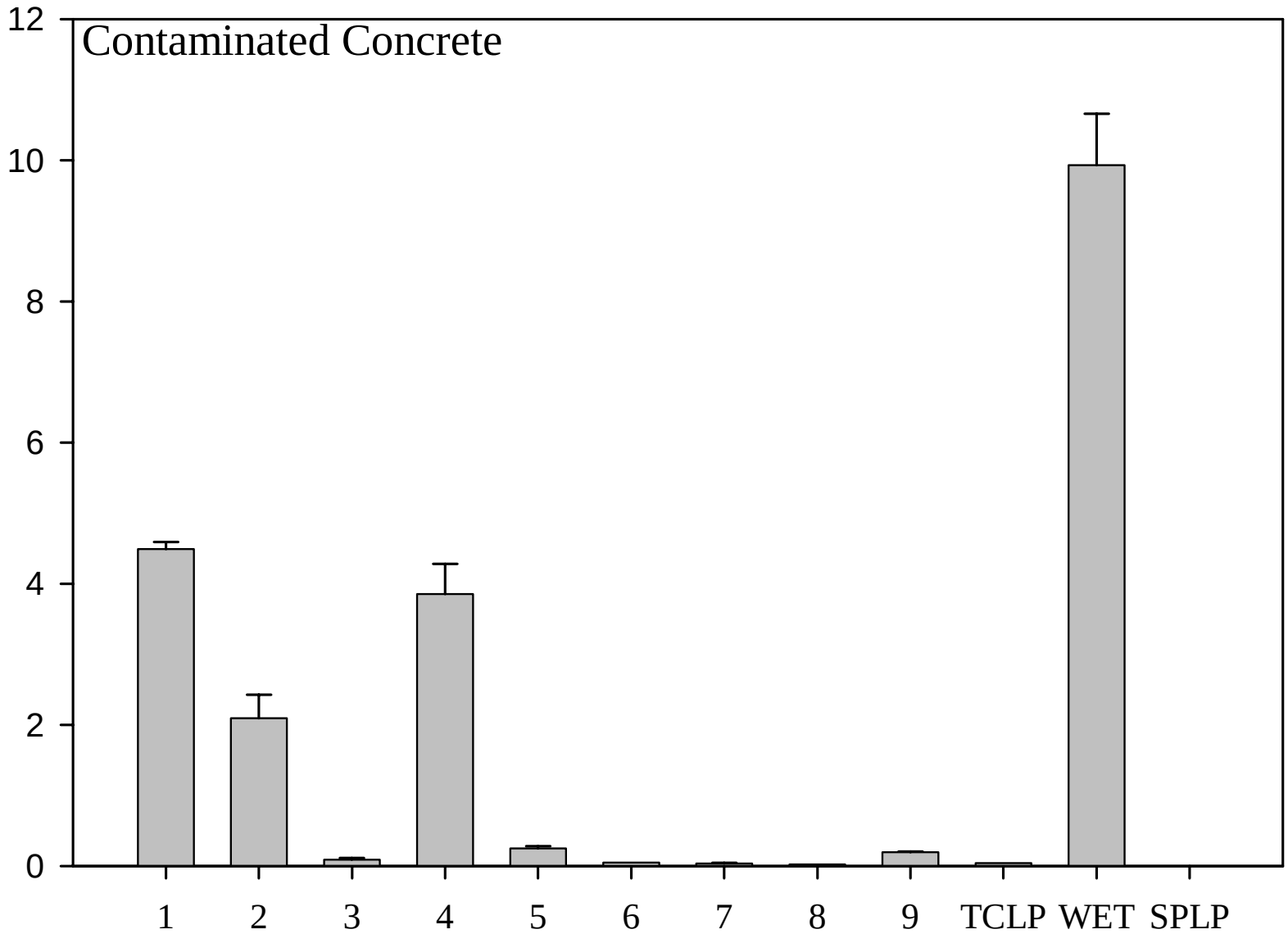


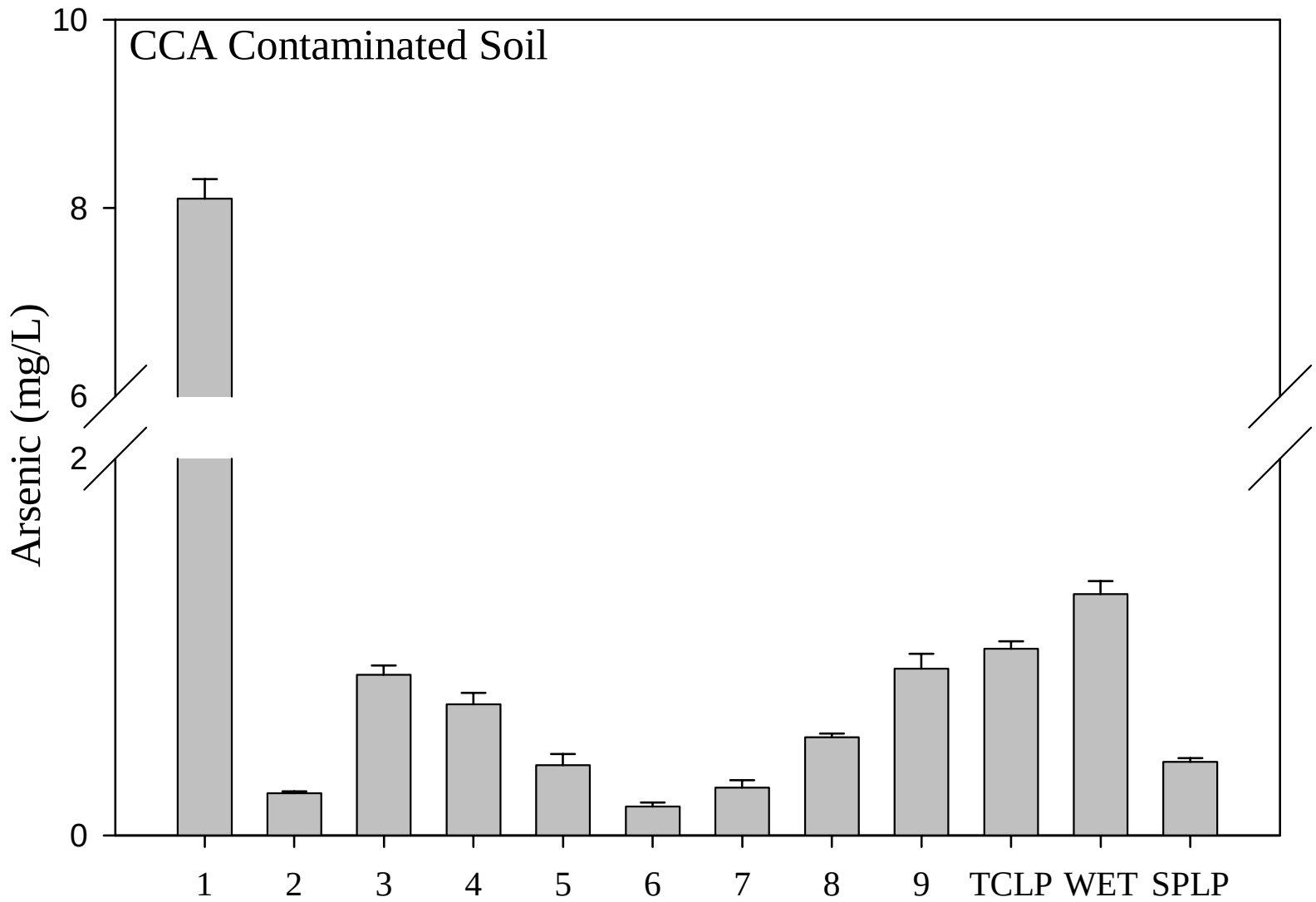
Printed Wire Boards


Mining Waste
Arsenic (mg/L)
100
5
0
1
2
3
4
5
6
7
8
9
TCLP
WET
SPLP


CCA Sawdust
60
50
10
0
1
2
3
4
5
6
7
8
9
TCLP
WET
SPLP

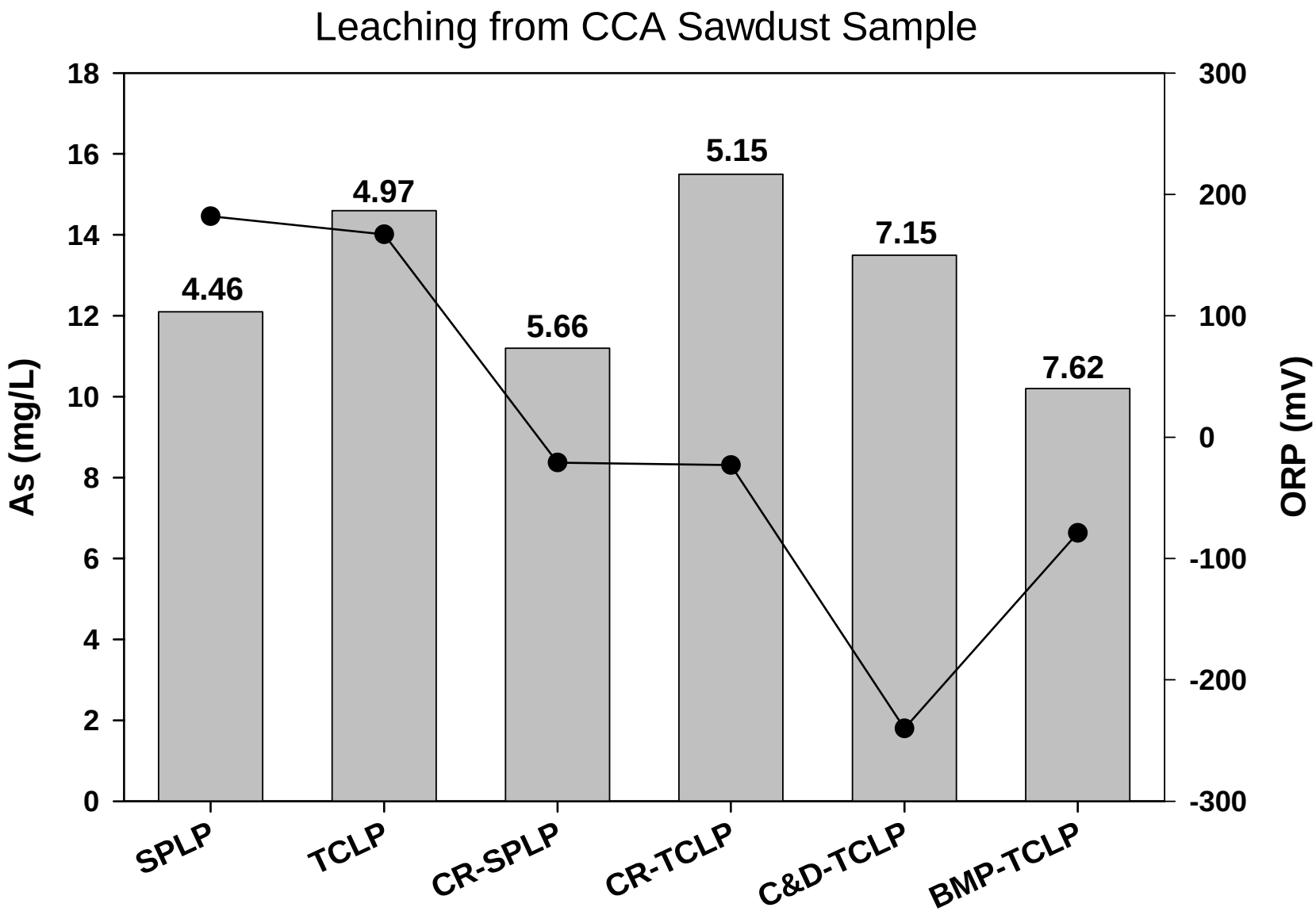

CCA Ash
Arsenic (mg/L)
400
300
200
100
0
1
2
3
4
5
6
7
8
9
TCLP
WET
SPLP

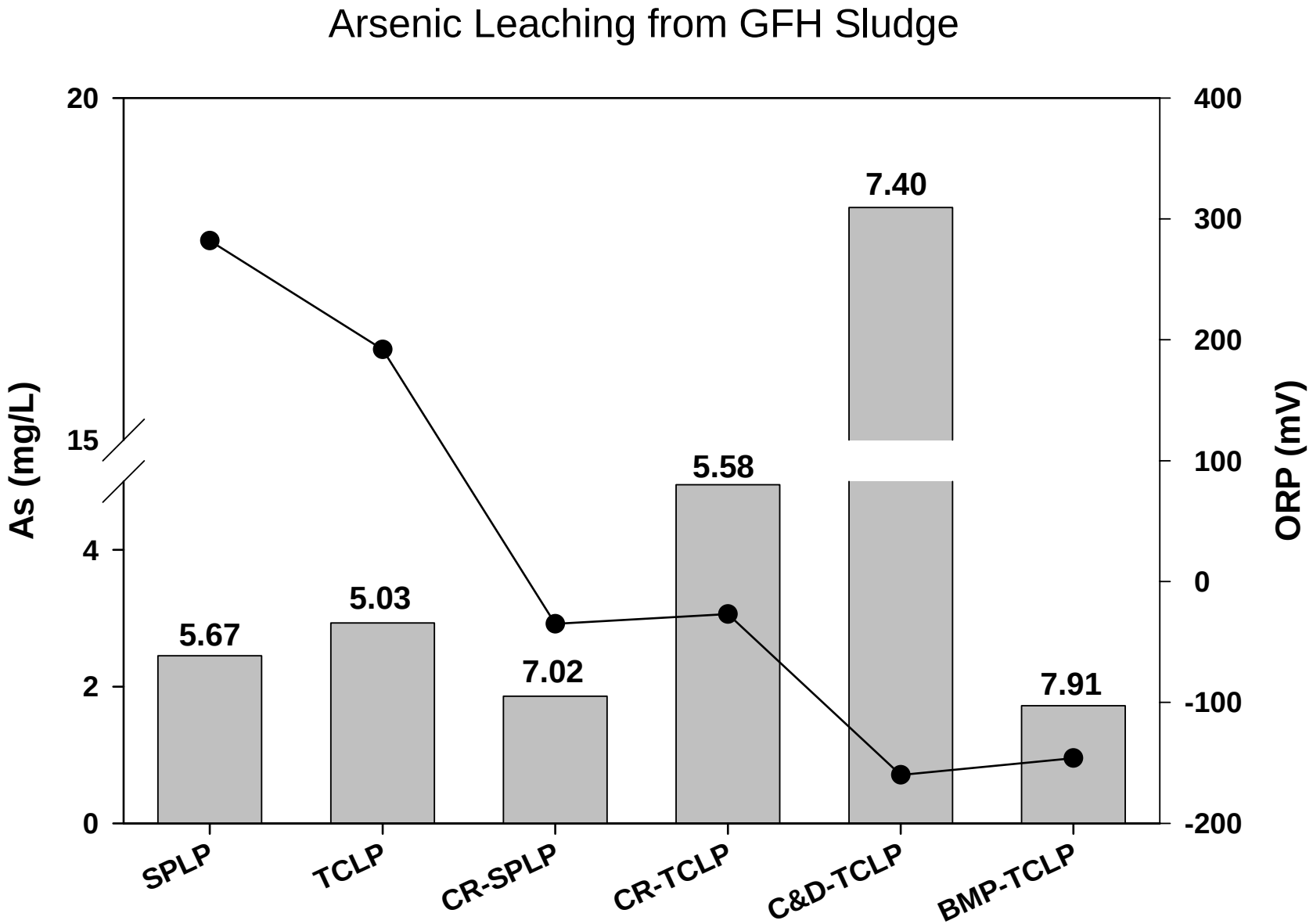

Contaminated Concrete
12
10
8
6
4
2
0
1
2
3
4
5
6
7
8
9
TCLP
WET
SPLP


CCA Contaminated Soil
Arsenic (mg/L)
10
8
6
2
0
1
2
3
4
5
6
7
8
9
TCLP
WET
SPLP

Many Reasons for the Difference

- pH
- Leachate chemistry
- Redox conditions
- Interactions with waste and other chemicals in leachate
  - Precipitation
  - Sorption


Leaching from CCA Sawdust Sample
As (mg/L)
ORP (mV)
18
16
14
12
10
8
6
4
2
0
300
200
100
0
-100
-200
-300
4.46
4.97
5.66
5.15
7.15
7.62
SPLP
TCLP
CR-SPLP
CR-TCLP
C&D-TCLP
BMP-TCLP


Arsenic Leaching from GFH Sludge
As (mg/L)
ORP (mV)
20
15
4
2
0
400
300
200
100
0
-100
-200
5.67
5.03
7.02
5.58
7.40
7.91
SPLP
TCLP
CR-SPLP
CR-TCLP
C&D-TCLP
BMP-TCLP

Simulated Landfills


SPEED
LIMIT
5


Plastic


Food waste from Publix


A scale was used to weigh components.
WE RECYCLE


Paper and Cardboard
Non-putrescible wastes
• Plastic
• Glass
• Steel
• Wood
• Yard Waste
• Aluminum
Putrescible wastes
• Vegetable and Fruit Waste
• Cat Food
WE RECYCLE


WE
RECYCLE


RECYCLING
000071


Computer Monitor

Cell Phones


Desktop Computer

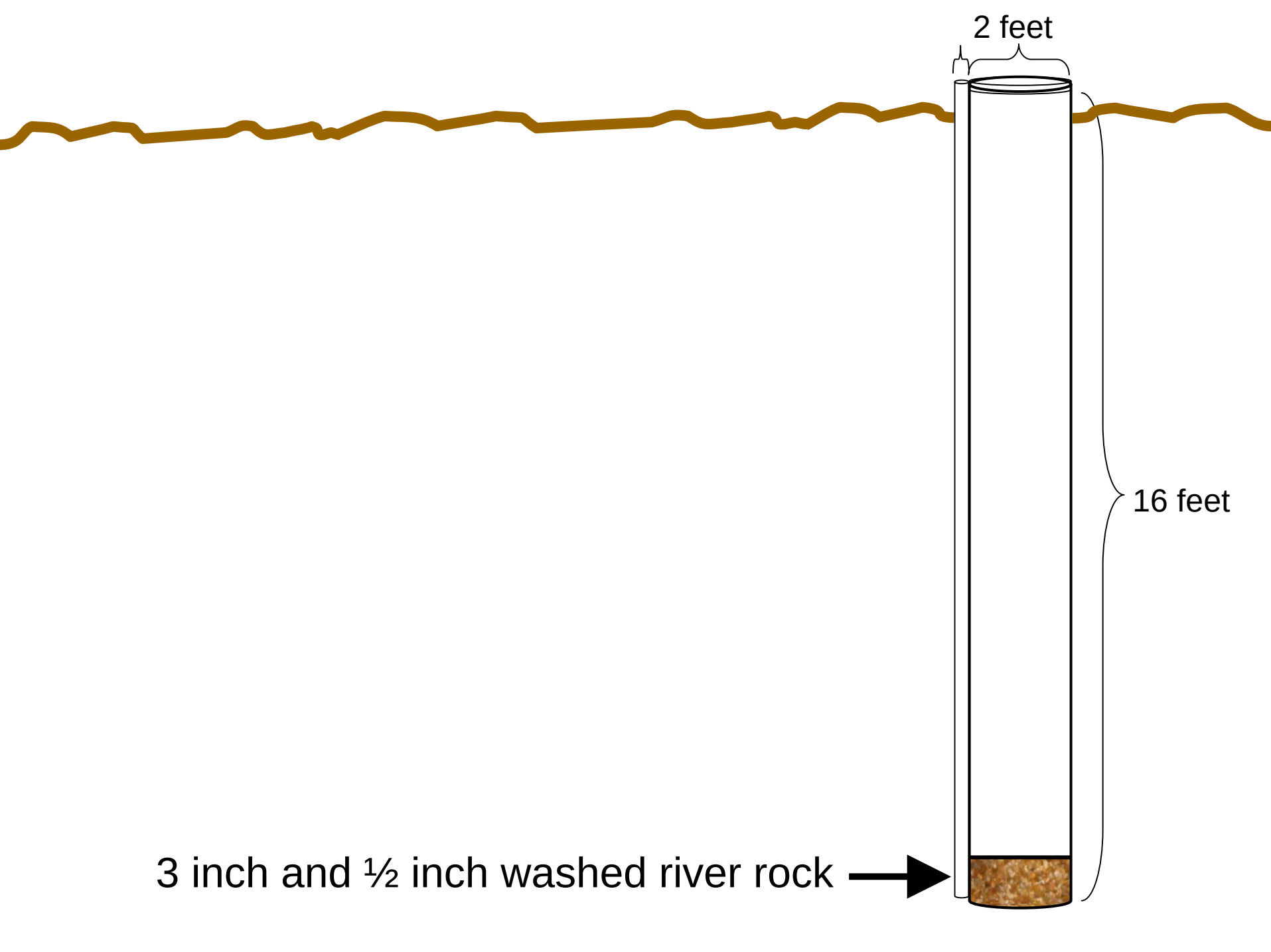

Smoke Detector

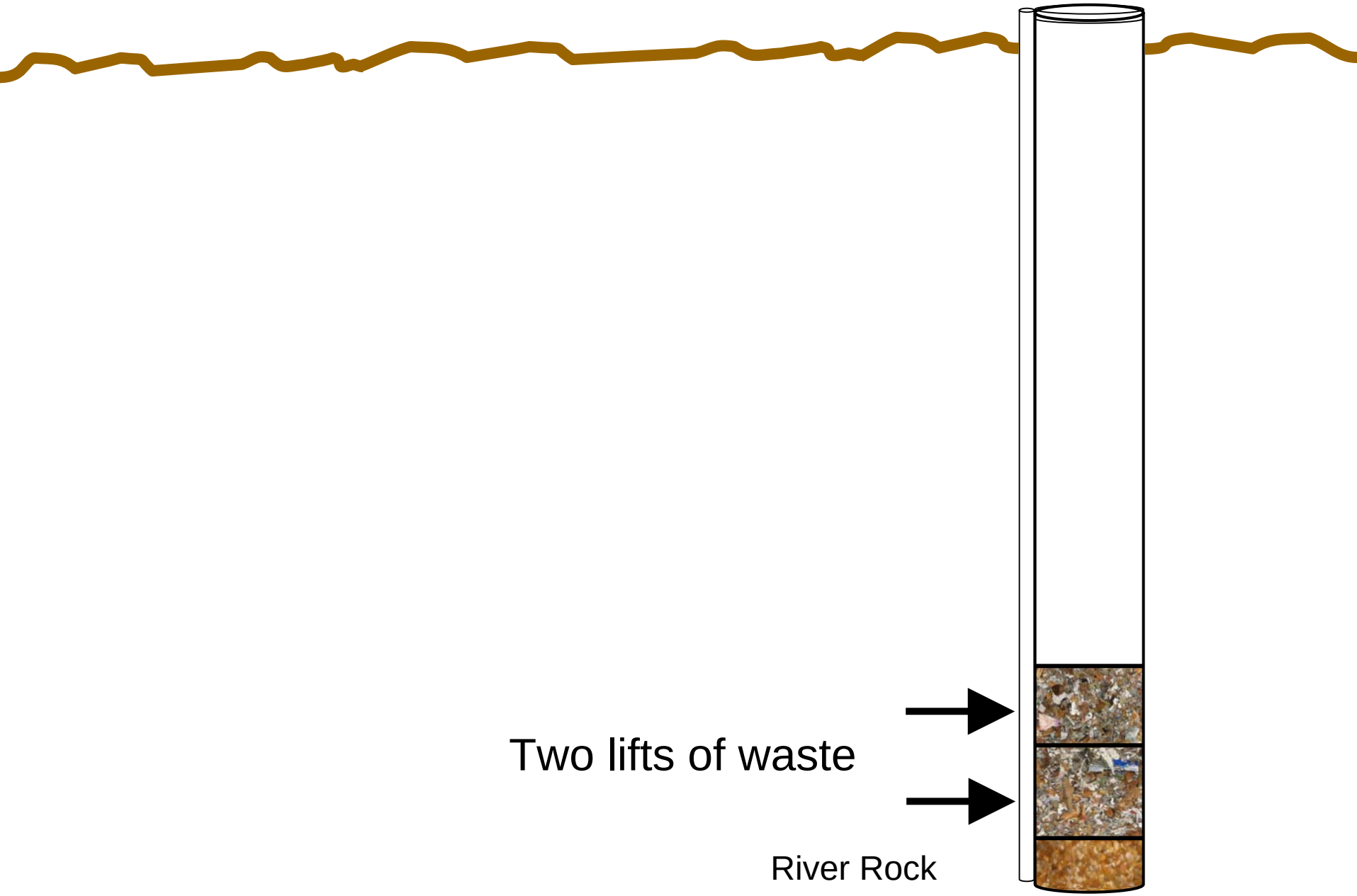

SPEED LIMIT 5


SPEED LIMIT 5

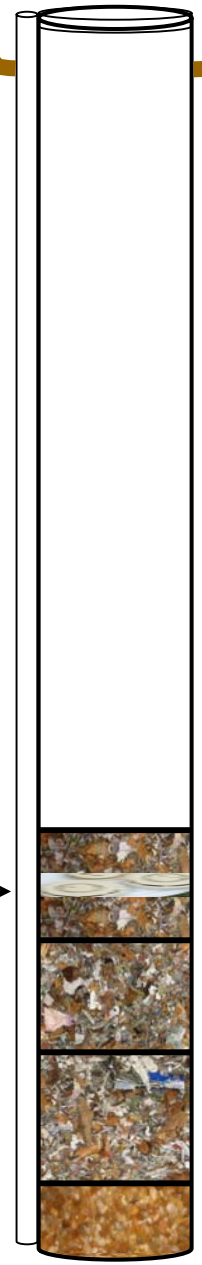
2 feet
16 feet

2 feet
16 feet


2 feet
16 feet
3 inch and ½ inch washed river rock

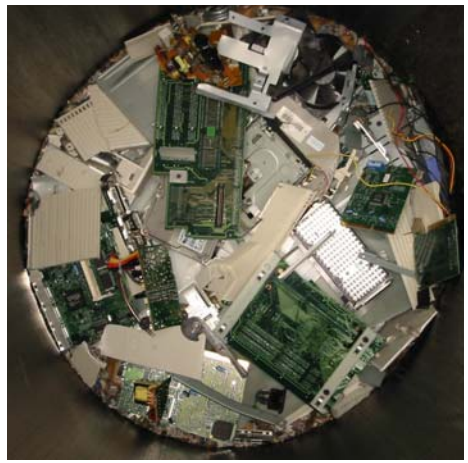

Two lifts of waste
River Rock

3 Smoke detectors mixed into middle of lift



Two Lifts of Waste

River Rock



1 CPU mixed into middle of lift

Smoke Detectors

Two Lifts of Waste

River Rock

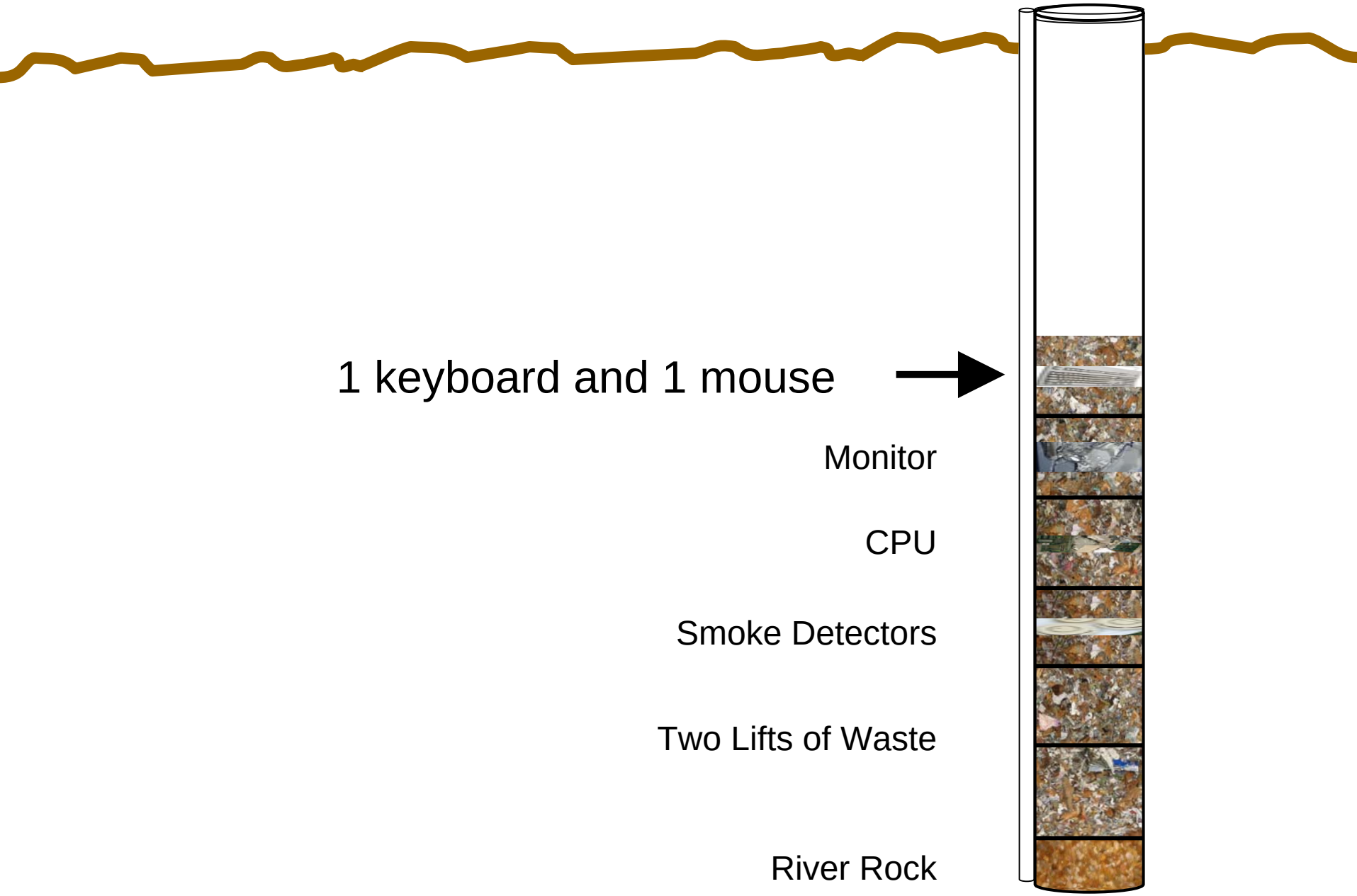
1 monitor mixed into middle of lift

CPU

Smoke Detectors

Two Lifts of Waste

River Rock


1 keyboard and 1 mouse
Monitor
CPU
Smoke Detectors
Two Lifts of Waste
River Rock

4 Cell Phones and 8 Ni-Cd Batteries

Keyboard and Mouse

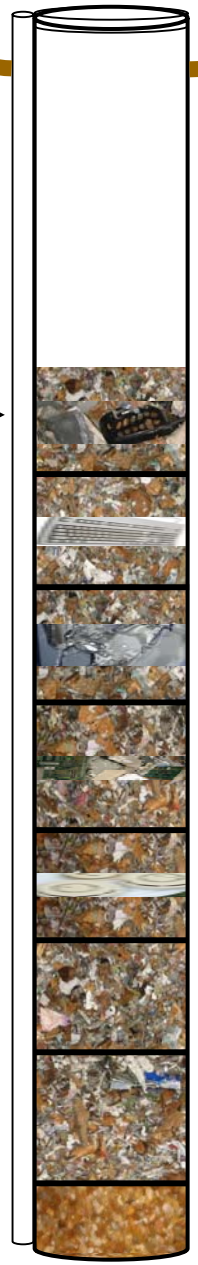
Monitor

CPU

Smoke Detectors

Two Lifts of Waste

River Rock



Three lifts of waste

Cell Phones and Ni-Cd Batteries

Keyboard and Mouse

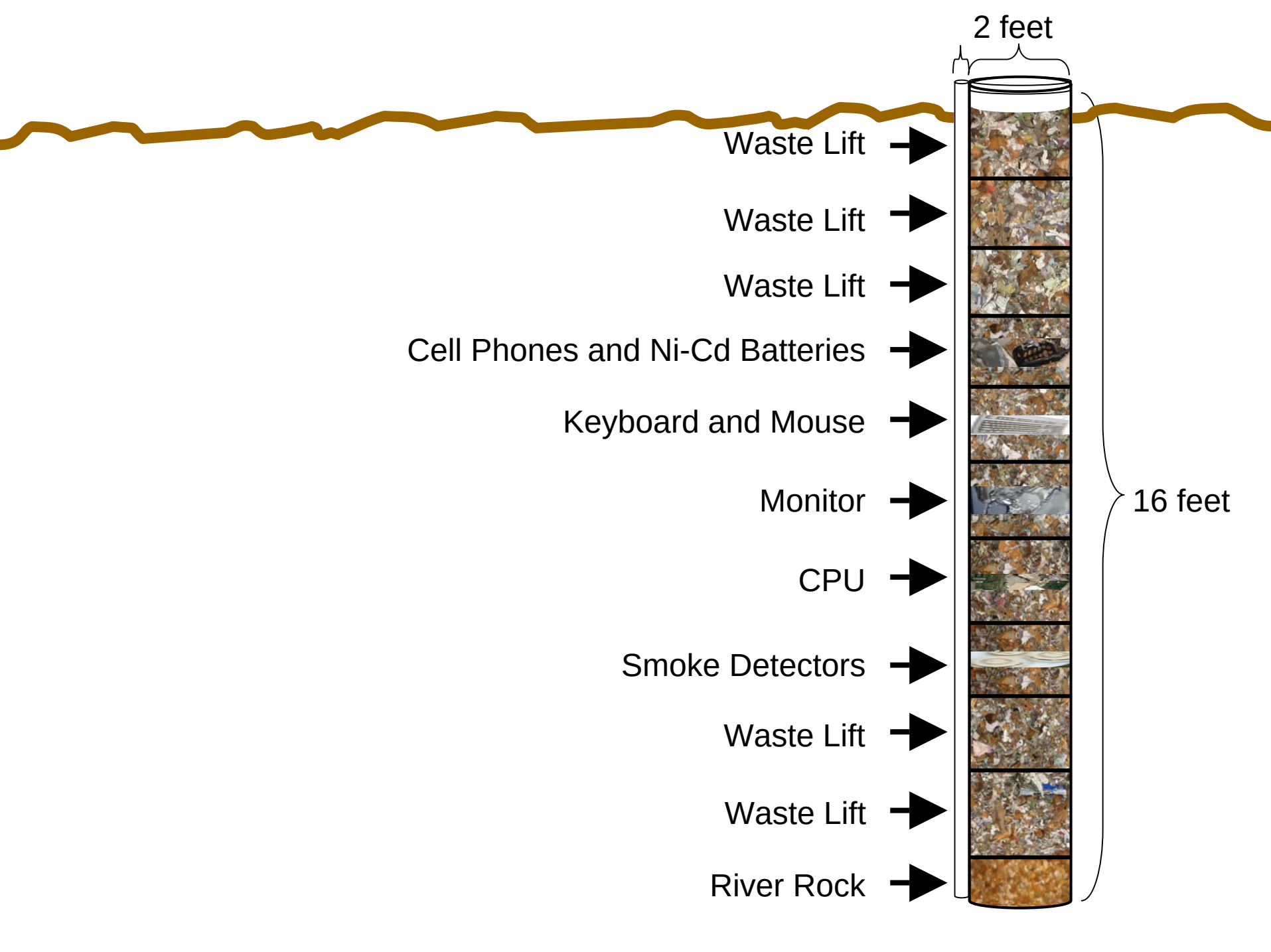
Monitor

CPU

Smoke Detectors

Two Lifts of Waste

River Rock

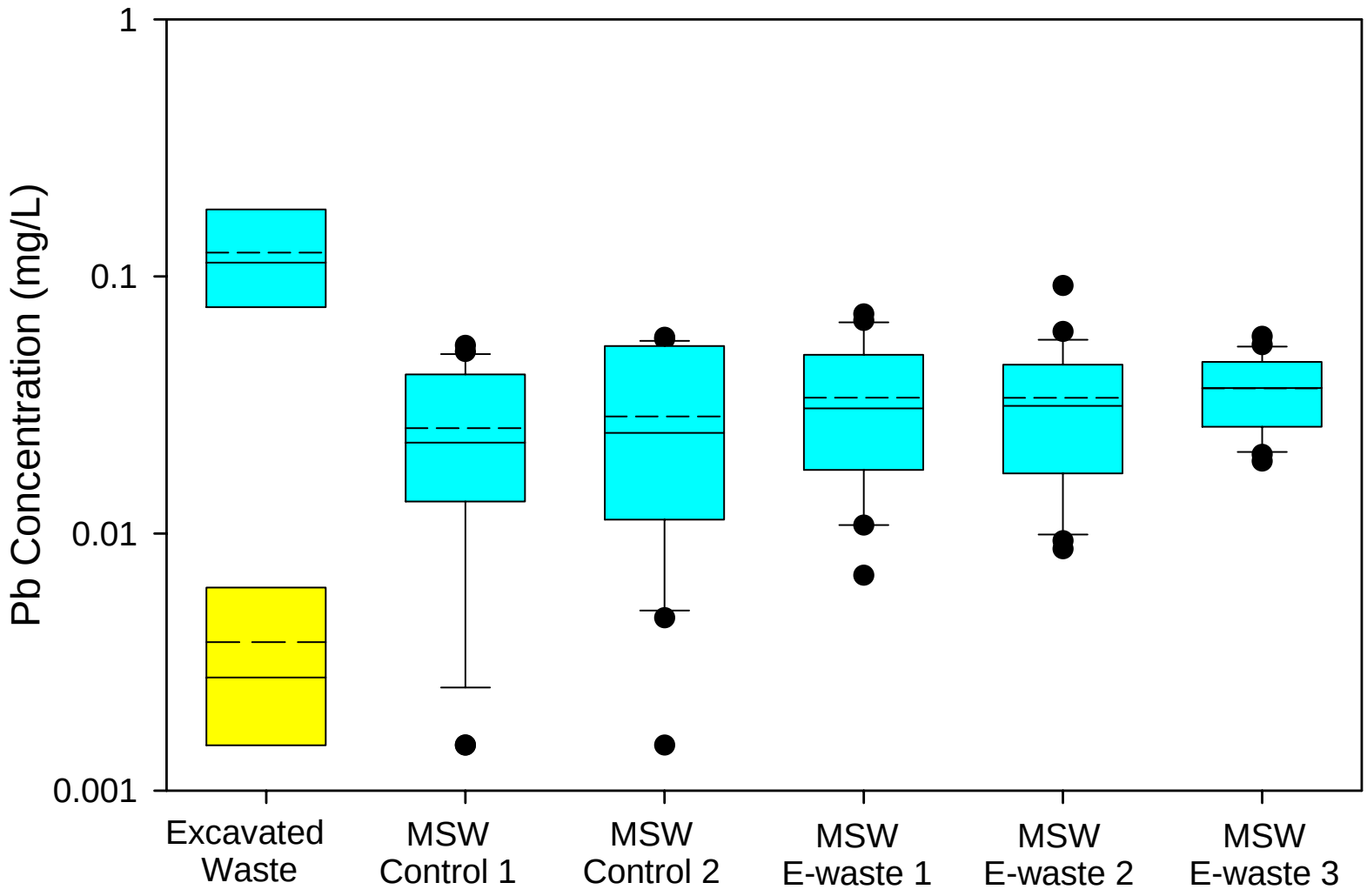

2 feet
Waste Lift
Waste Lift
Waste Lift
Cell Phones and Ni-Cd Batteries
Keyboard and Mouse
Monitor
CPU
Smoke Detectors
Waste Lift
Waste Lift
River Rock
16 feet

Water distribution system

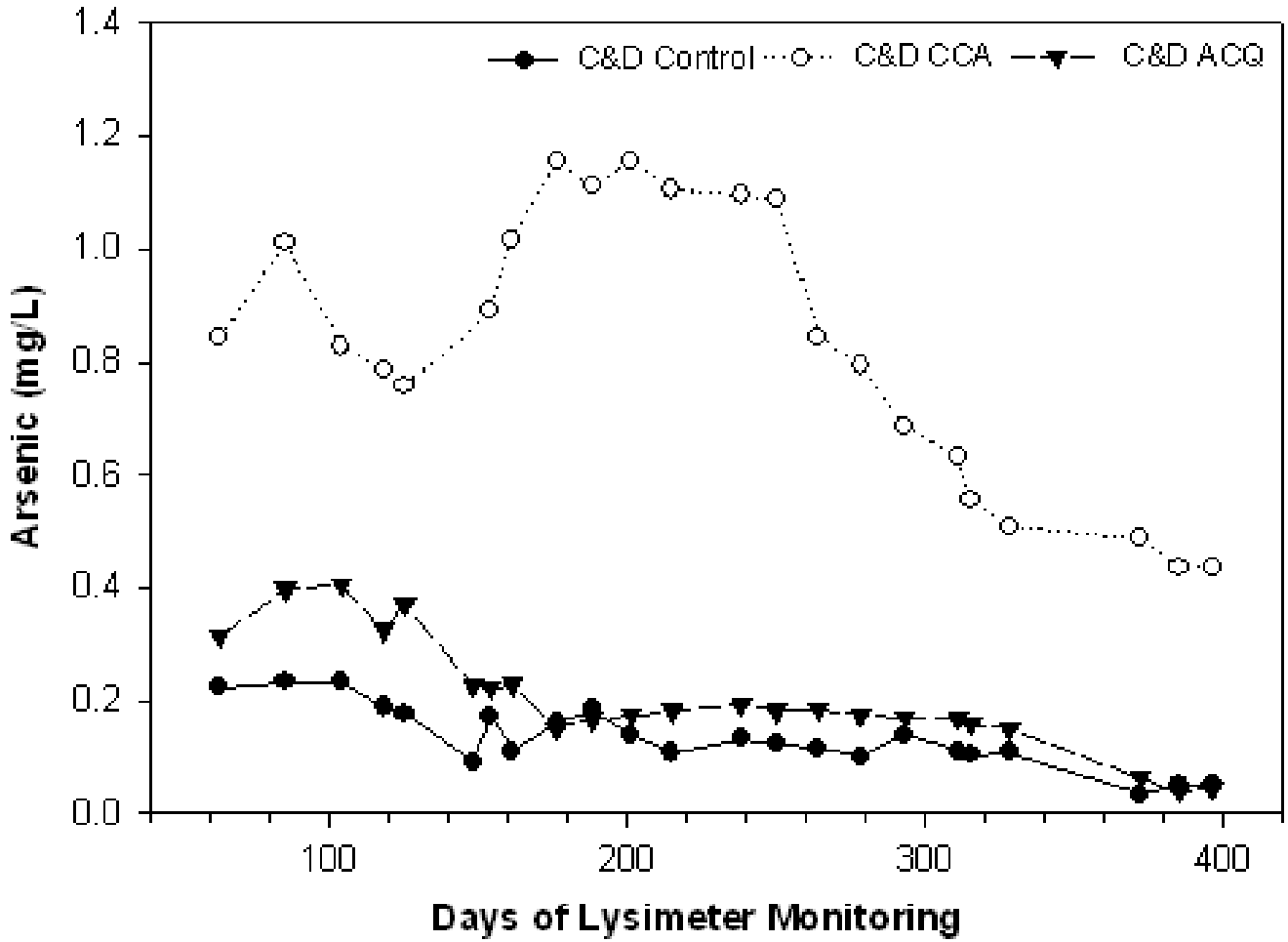
Water addition

Box Plot of Leachate Lead Concentrations

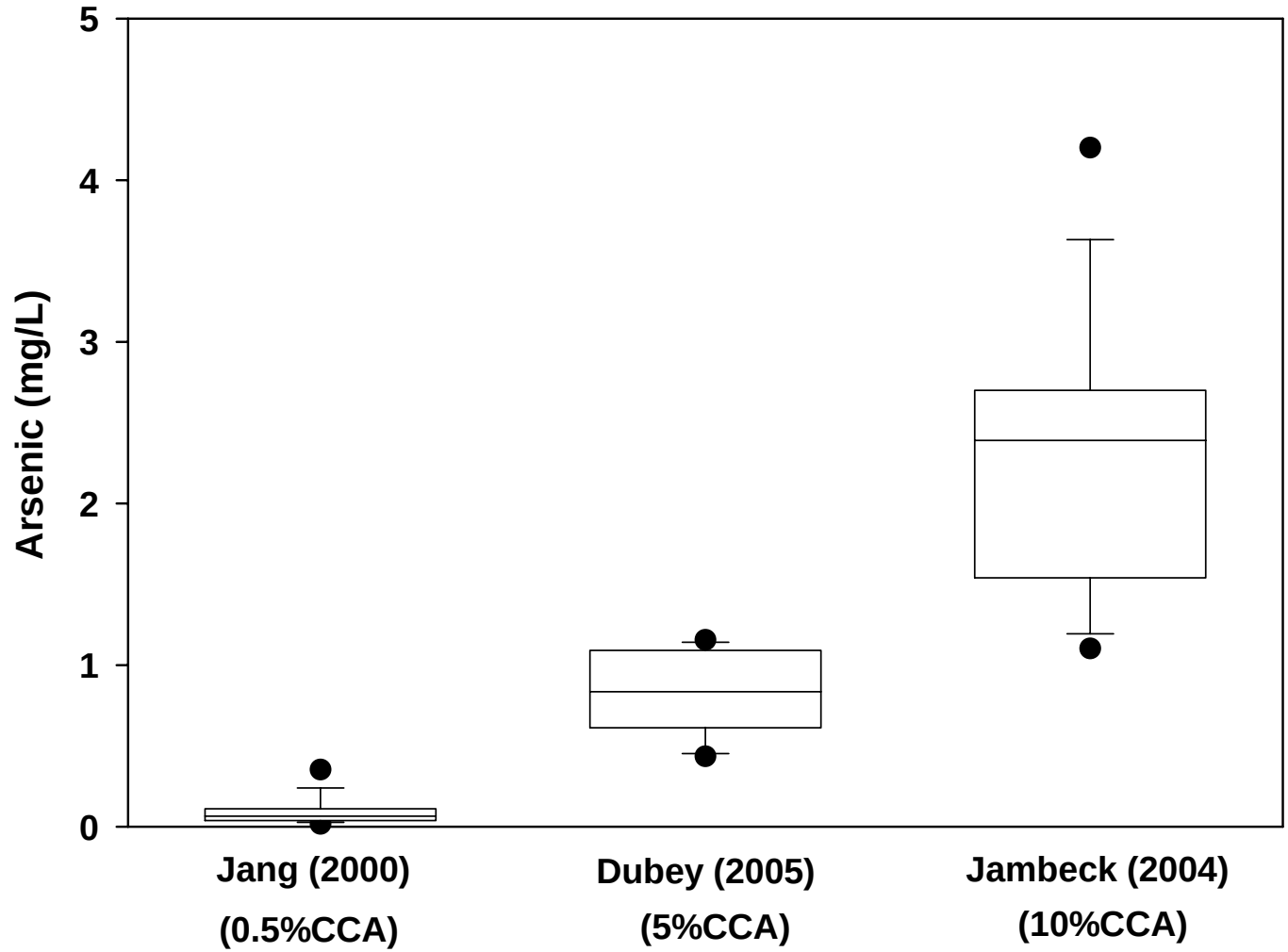
(Leachates with pH less than 7 in cyan, pH greater than 7 in yellow)



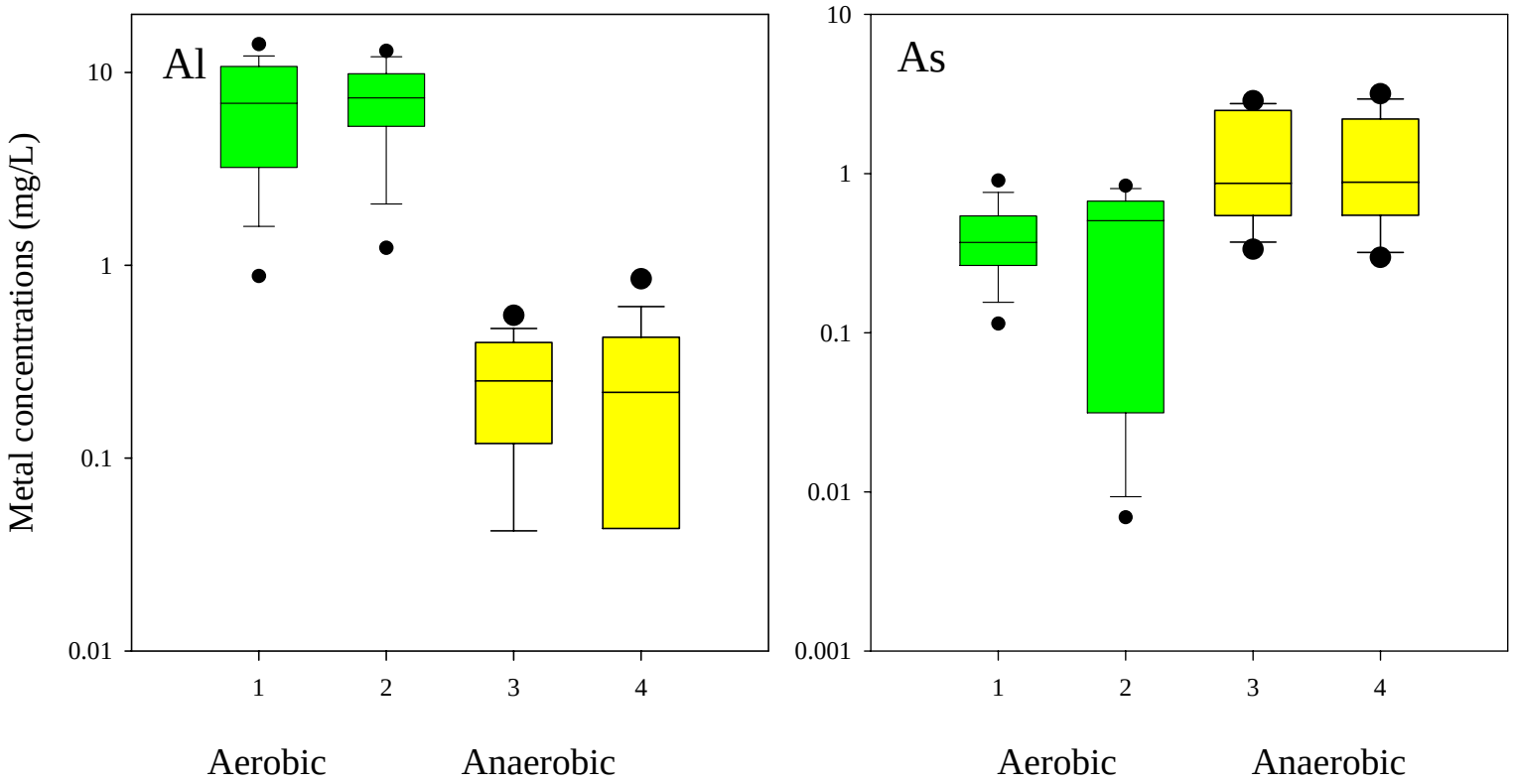
Arsenic vs. Time in C&D Lysimeter Leachate



Arsenic Concentration in CCA Lysimeter Leachates from Three C&D Lysimeter Projects



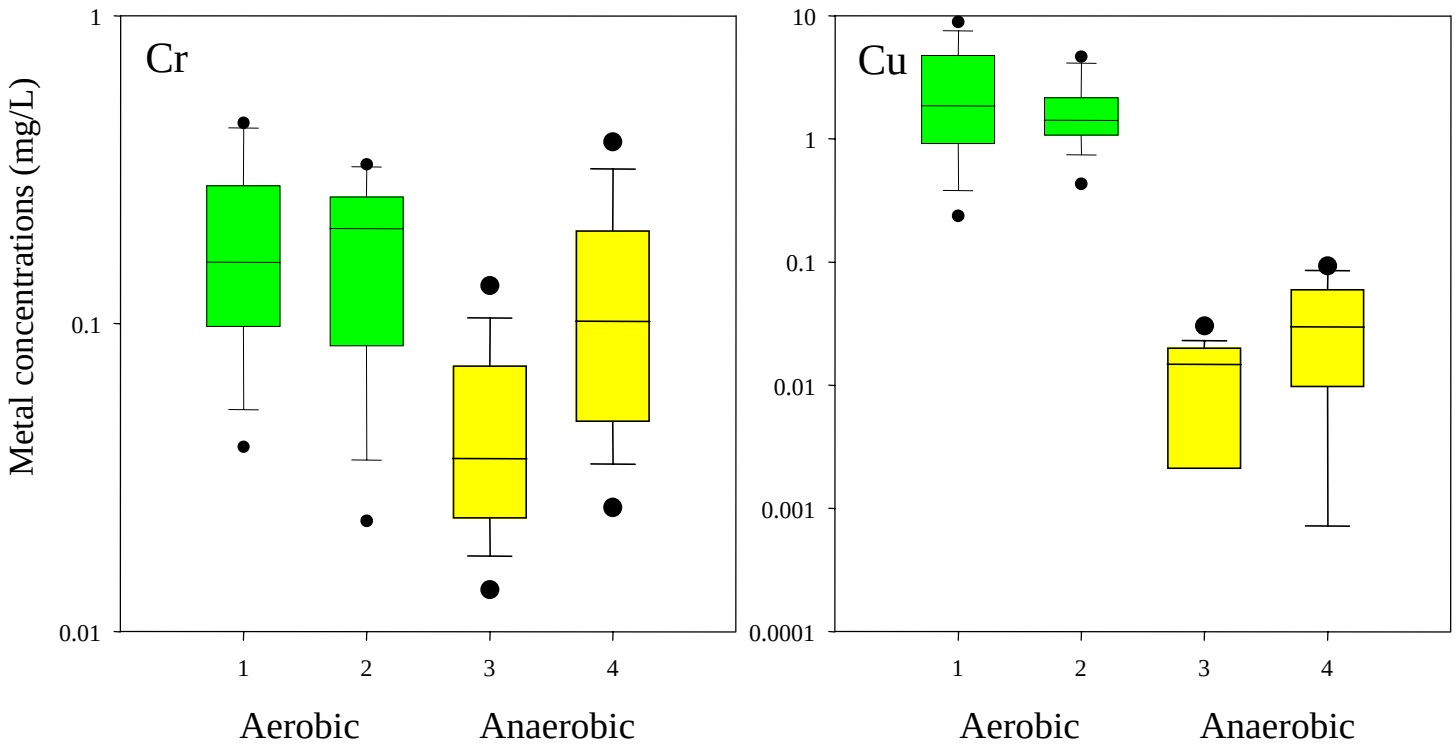
Comparison of concentrations of metal leached between aerobic and anaerobic lysimeters



Al: aerobic > anaerobic

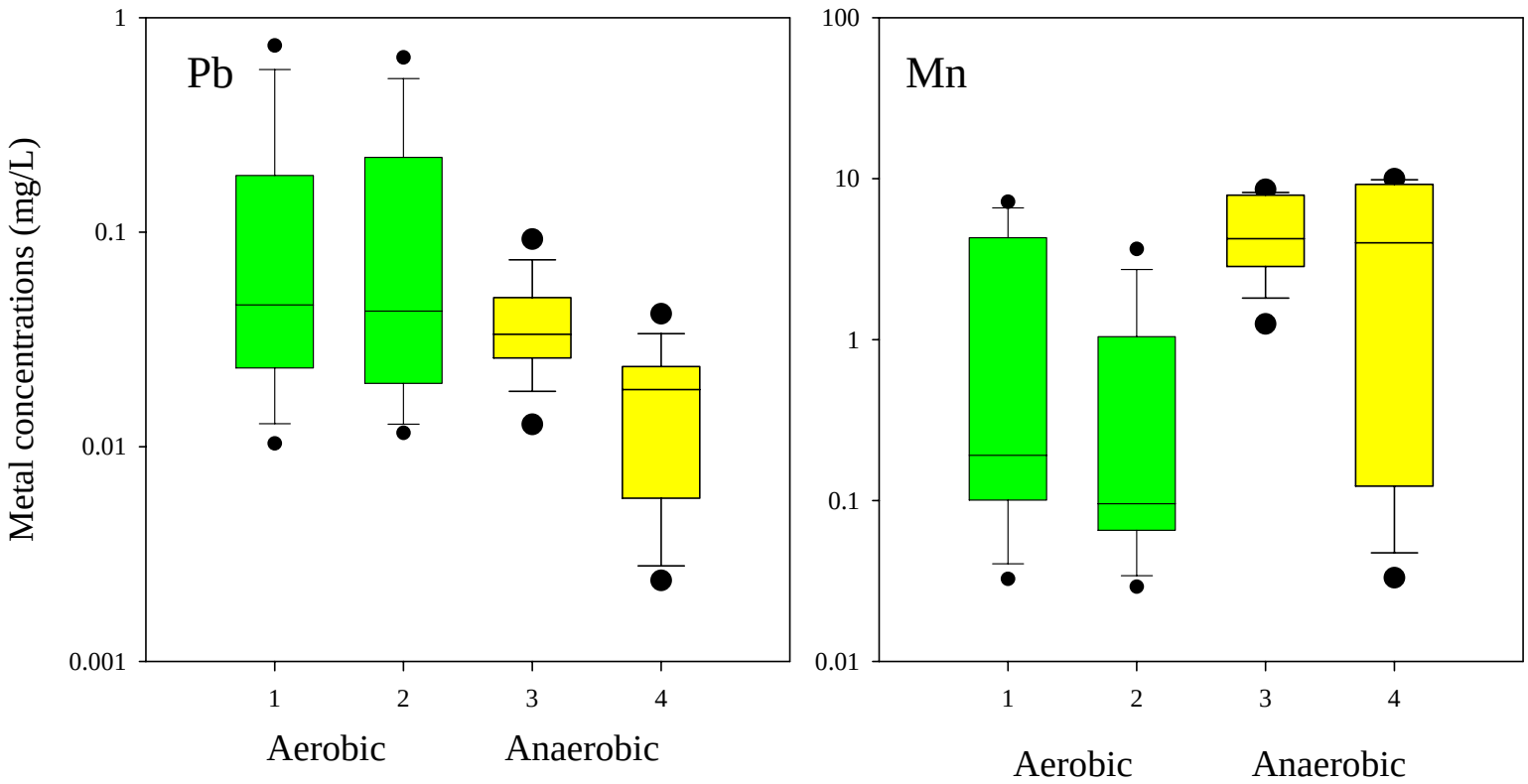
As: aerobic < anaerobic

Comparison of concentrations of metal leached between aerobic and anaerobic lysimeters

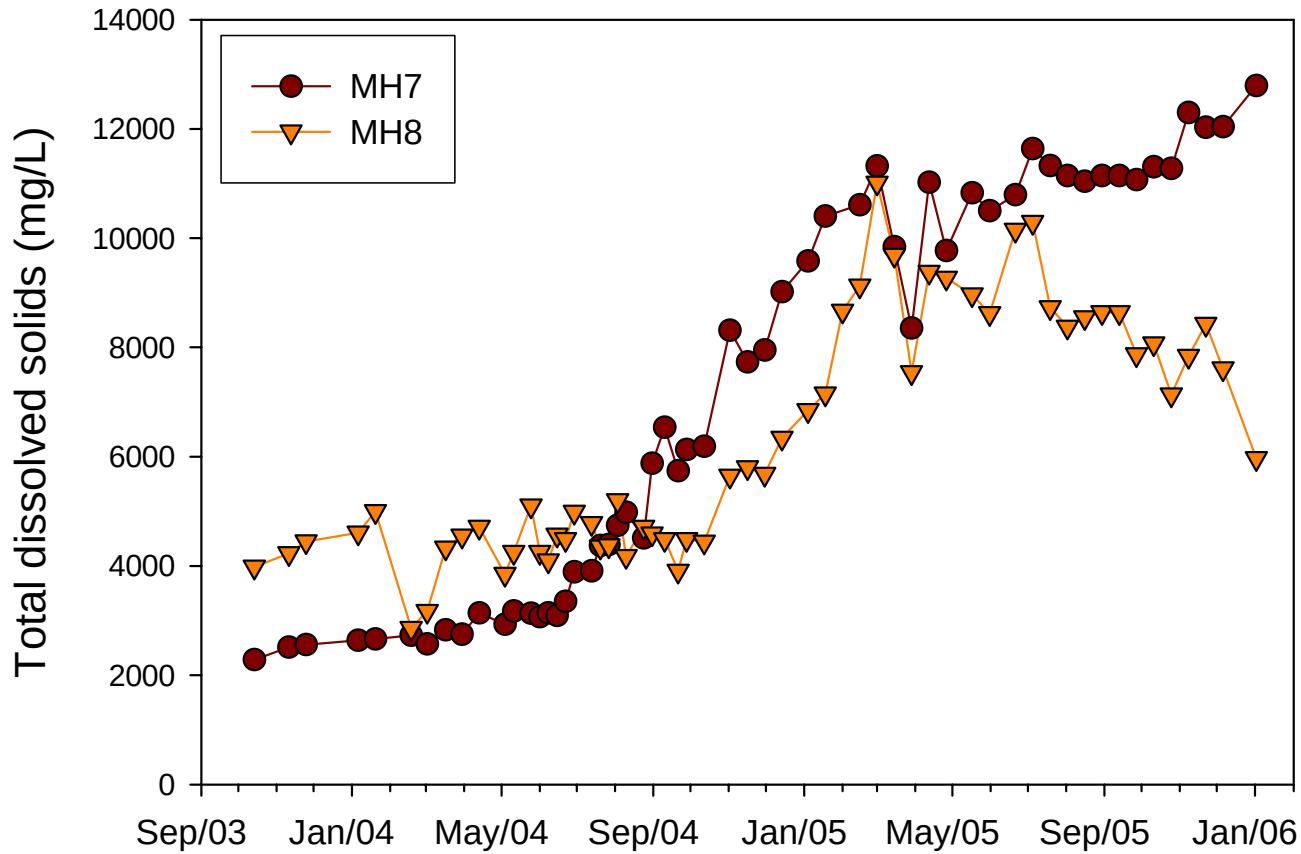


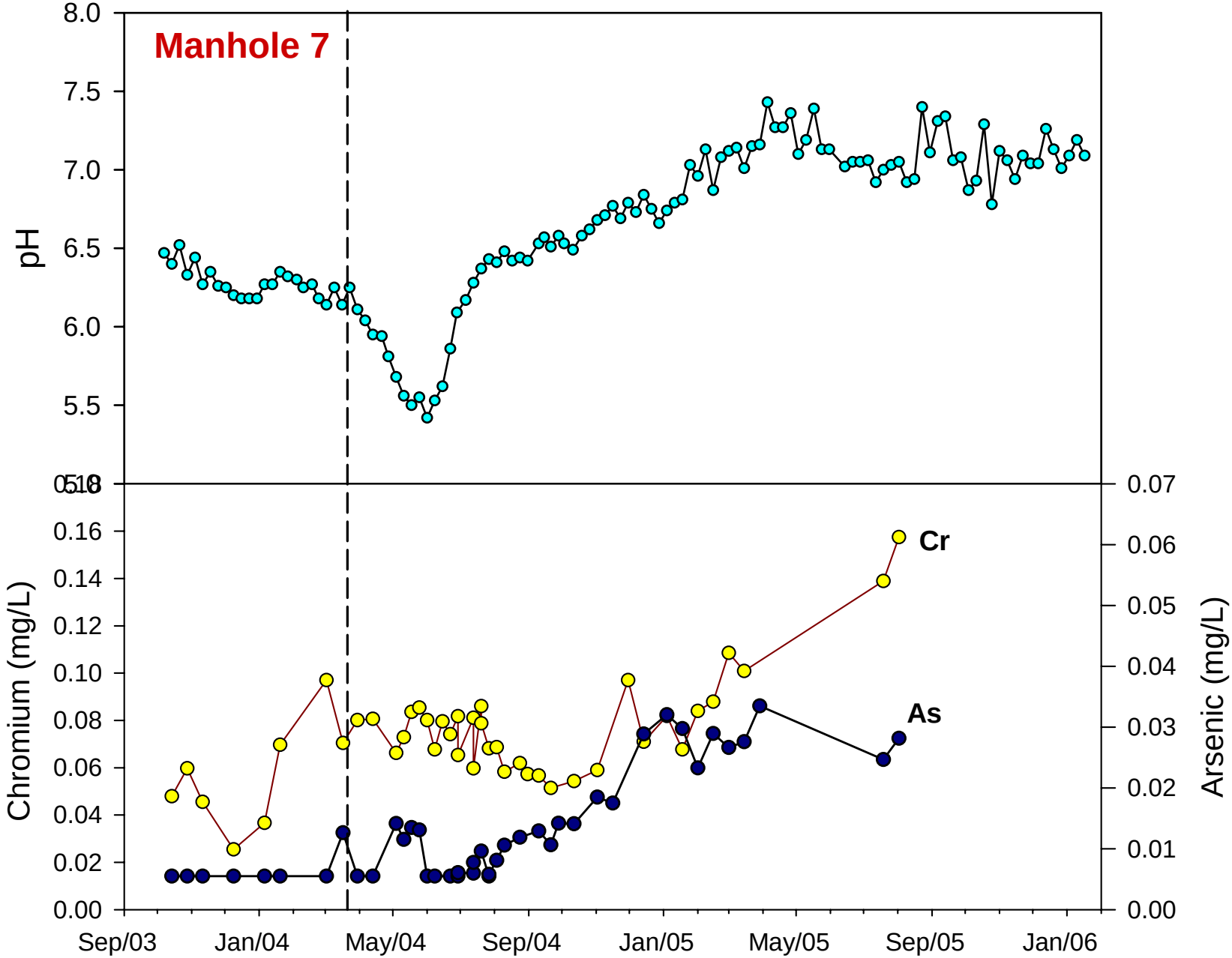
Cr: aerobic > anaerobic
Cu: aerobic > anaerobic

Comparison of concentrations of metal leached between aerobic and anaerobic lysimeters

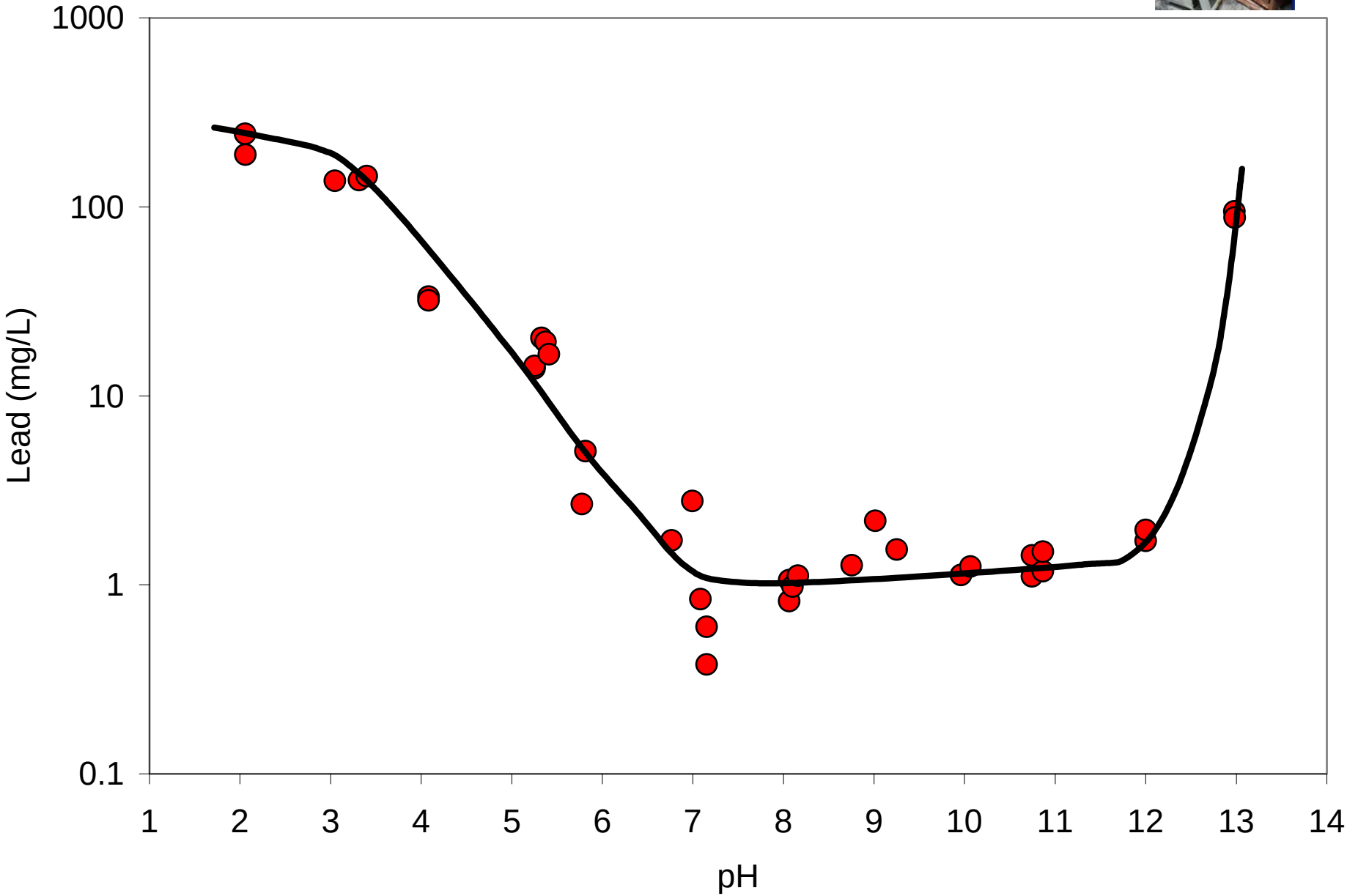


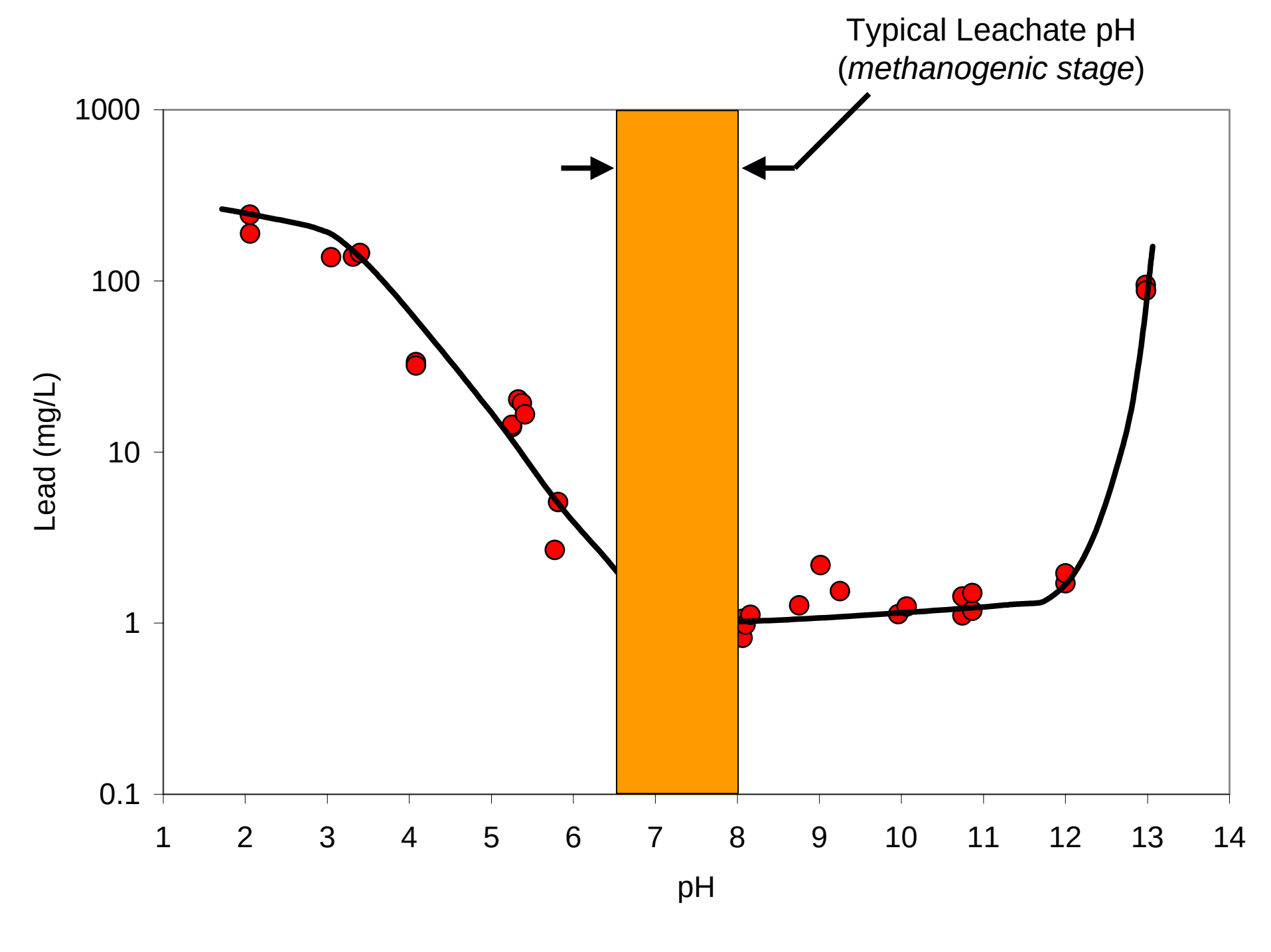
Pb: aerobic > anaerobic
Mn: aerobic < anaerobic

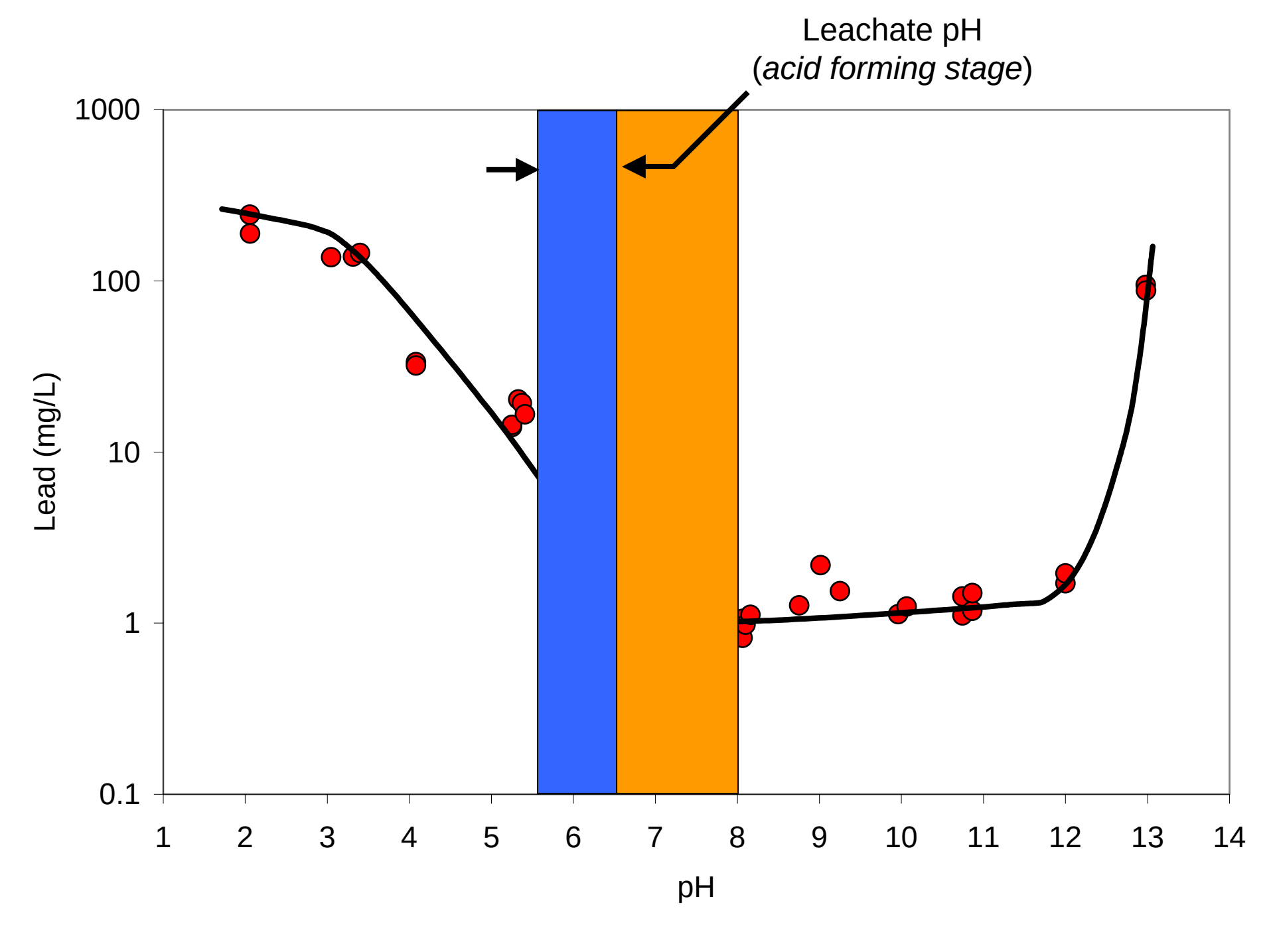

Total dissolved solids (mg/L)
14000
12000
10000
8000
6000
4000
2000
0
Sep/03
Jan/04
May/04
Sep/04
Jan/05
May/05
Sep/05
Jan/06
MH7
MH8

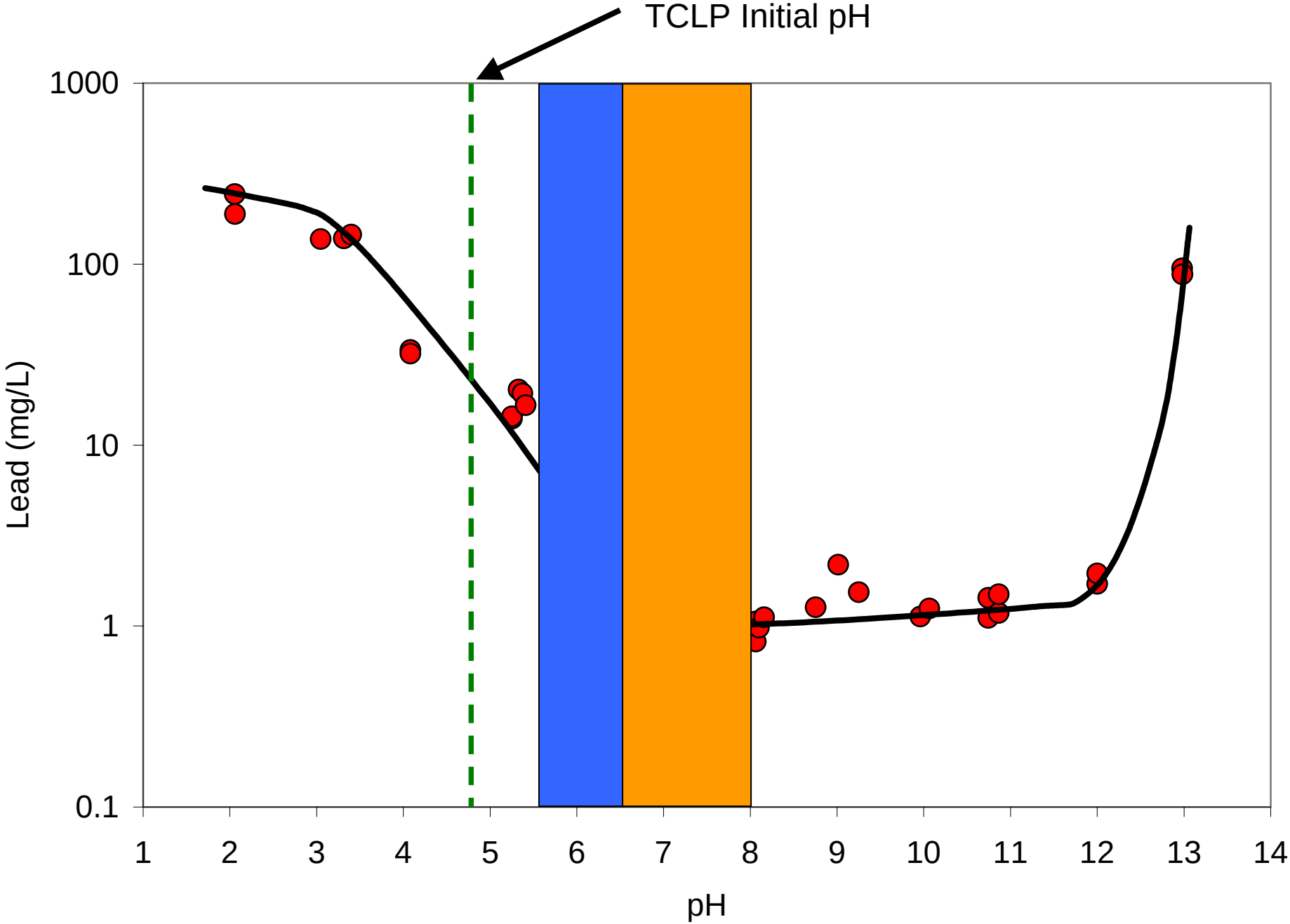

Manhole 7
pH
8.0
7.5
7.0
6.5
6.0
5.5
Chromium (mg/L)
0.18
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
Arsenic (mg/L)
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
Cr
As
Sep/03
Jan/04
May/04
Sep/04
Jan/05
May/05
Sep/05
Jan/06

Lead Leaching from CRT Glass: Impact of pH




Typical Leachate pH
(*methanogenic stage*)
1000
100
10
1
0.1
Lead (mg/L)
1
2
3
4
5
6
7
8
9
10
11
12
13
14
pH


Leachate pH
(acid forming stage)
1000
100
10
1
0.1
Lead (mg/L)
1
2
3
4
5
6
7
8
9
10
11
12
13
14
pH


TCLP Initial pH
1000
100
10
1
0.1
Lead (mg/L)
1
2
3
4
5
6
7
8
9
10
11
12
13
14
pH